**Proceedings of the American Academy of Arts and Sciences.**

VOL. XXXVI. No. 28. — APRIL, 1901.

---

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.

# *THE SOLUBILITY OF MANGANOUS SULPHATE.*

BY THEODORE WILLIAM RICHARDS AND FRANK ROY FRAPRIE.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.

# THE SOLUBILITY OF MANGANOUS SULPHATE.

By Theodore William Richards and Frank Roy Fraprie.

Presented by T. W. Richards, March 13, 1901. Received March 21, 1901.

The solubility of manganous sulphate has been carefully determined within the past year by F. G. Cottrell,* and the present paper is written to confirm in some measure the results of his work. He was able to disprove by well-considered experiment the less recent work of Linebarger,† who published a singular series of results resting upon faulty reasoning and an erroneous method of experimentation. In a case of this kind, when authorities differ, the truth is more quickly enforced when it is supported, hence the publication of the present paper.

The work to be recorded below was done in the spring of 1898, long before the work of Cottrell. It was part of a still unfinished investigation which has as its object the study of the transition equilibria of potassic manganous sulphate. We hope that circumstances may permit the early publication of the remainder of this work, which has been suspended for a time.‡

It was soon found that a much higher temperature was necessary to drive off the water of crystallization of manganous sulphate than has usually been supposed. Linebarger used only 180°, at which temperature at least one molecule of water remains in the salt if it is surrounded by air with the usual proportion of aqueous vapor. The handbooks name 210° to 240° as the temperature required, and Cottrell, calling attention to Linebarger's error, used 280°. We found that traces of water still remained after heating for half an hour at 350° in an air bath. In this respect the substance reminds one of cupric sulphate.§ The amount thus retained does not much exceed the tenth of a per cent, and the effect upon

* Cottrell, J. phys. ch., **4**, 637 (1900).

† Linebarger. Am. Chem. Journal, **15**, 225 (1893).

‡ A brief statement of the scope and object of this work will be found in Proc. Am. Ass. Adv. Sc., 213 (1898).

§ Richards, Proc. Am. Acad., **26**, 240 (1891).

Cottrell's results could not have been serious. On the other hand, a temperature just below redness, perhaps 450°, obtained with a carefully watched naked flame, and applied after long drying at lower temperature, was capable of driving off in five minutes so much of the water that subsequent similar heating for a quarter of an hour showed only an average loss of 0.2 milligram. The product was wholly soluble in water, showing that no decomposition of the sulphate itself had occurred.

The manganous sulphate was purified with great care, and the crystals employed were coarsely powdered. The specimen whose solubility was to be determined was put into a large stout test-tube with a carefully cleaned rubber stopper, and was kept for at least four hours at the desired temperature in an Ostwald thermostat before a sample was taken. The agitation of the mixture was active and continual, being effected by an apparatus similar in principle to that of Schröder.* The motive power was a Henrici hot-air motor. At the close of the appointed time the sample to be analyzed was removed by an effectual filtering pipette, somewhat similar to one which has since been used in van't Hoff's laboratory.† A diagram of the pipette is appended.

FILTERING PIPETTE.

The filtering attachment, filled with cotton wool ("absorbent cotton," C), is temporarily attached to the jet A of a 5-c.c. pipette by means of the rubber tube B.

The cotton was very necessary to filter off the fine powder which appeared during the stirring. In order to avoid change of temperature, the pipette was previously warmed by placing it in a dry test-tube immersed in the thermostat. Only the mouth of the test-tube was allowed to project above the water of the thermostat, and of course every precaution was taken to obtain a fair sample of the solution.

After filling the pipette and quickly removing the rubber filtering-jet attached to it, the clear solution was run into a weighing-bottle and was quickly stoppered and weighed. The known amount of solution was washed into a roomy platinum crucible, when it was cautiously evaporated,

* Schröder, Zeitschr. phys. chem., **11**, 454 (1893); Noyes, ibid., **9**, 606 (1892). For details see Richards and Faber, Am. Chem. Journal, **21**, 168 (1899.)

† Van't Hoff and Meyerhoffer, Z. phys. ch., **27**, 79 (1898).

and the residue was ignited in the fashion already described. In order to make certain that no transition had occurred during the experiment, the crystal-water contained in the solid phase left over after the saturation was always determined. Below are the data thus obtained.

THE SOLUBILITY OF $MnSO_4 . 5H_2O$ AT 25°.

| No. of Determination. | Time of Saturation. | Weight of Solution. | Weight of $MnSO_4$. | $MnSO_4$ for 100 gr. Water. |
|---|---|---|---|---|
| | hours. | grams. | grams. | grams. |
| 1 | 6 | 5.0342 | 1.9849 | 65.09 |
| 2 | 6 | 6.3405 | 2.4947 | 64.89 |
| 3 | 8 | 4.4318 | 1.7470 | 65.07 |
| 4 | 8 | 5.2465 | 2.0656 | 64.94 |
| | | | Average . . . . . | 64.99 |
| 5 | 48 | 3.4514 | 1.3622 | 65.20 |
| 6 | 72 | 3.5349 | 1.3947 | 65.17 |
| | | | Average . . . . . | 65.19 |

Cottrell found 64.78 as a mean of two closely agreeing determinations, but the time allowed for saturation was only 2.2 hours. The probable reason for his slightly lower result will be discussed below.

The solubility of the tetrahydrate is recorded on the following page.

The solid material taken from the tubes in Determinations 7 to 10 contained as much as 4.3 molecules of water for each $MnSO_4$, but it was nevertheless probably the designated hydrate containing included mother liquor. The greater solubility of the pentahydrate at 30° would certainly involve the solution of any accessible pentahydrate. The salt remaining from determinations 11 and 12 contained 4.03 molecules of water.

The results at 30.15°, giving an average of 66.38, correspond almost exactly with Cottrell's figure 66.43 at 30°; but in this case his time of saturation was increased to an average of three hours, while ours was not much longer. Hence close correspondence was to have been expected, and the figures mutually support one another. The slight difference may be due to a residual trace of water in Cottrell's salt.

On the other hand, at 35° Cottrell used only two hours for saturation, while we used about seven times as much time. Hence the difference between his result, 67.87, and ours, 68.22, may be explained once more by a difference in the time of mixing.

Until recently the cause of this difference would have been ascribed to a possible incomplete saturation in Cottrell's case; and the higher figures, other things being equal, would have been accepted as the more accurate.

THE SOLUBILITY OF $MnSO_4.4H_2O$ AT 30.15° AND 35.0°.

| No. of Determination. | Temperature. | Time of Saturation. | Weight of Solution. | Weight of $MnSO_4$. | $MnSO_4$ for 100 gr. Water. |
|---|---|---|---|---|---|
| | | hours. | grams. | grams. | |
| 7 | 30.15° | 4 | 4.3125 | 1.7215 | 66.44 |
| 8 | 30.15° | 4 | 5.7567 | 2.2943 | 66.27 |
| 9 | 30.15° | 4 | 4.5992 | 1.8339 | 66.32 |
| 10 | 30.15° | 4 | 5.2322 | 2 0894 | 66.48 |
| | | | | Average . . . . . | 66.38 |
| 11 | 35.0° | 13 | 3.7009 | 1.5007 | 68.21 |
| 12 | 35.0° | 14.5 | 2.7854 | 1.1296 | 68.22 |
| | | | | Average . . . . . | 68.22 |

While this may be true, the recent work of Ostwald* on the solubility of powders and the surface tension of solids has thrown new light on this matter, and it seems quite possible that neither series of results may be perfectly definite. Fine powders have a greater solution-tension than coarse ones, for the same reason that small drops have a greater vapor tension than large ones.

It has often been stated that very long agitation is necessary to secure saturation.† In view of Ostwald's newer work it seems quite possible that continued active agitation introduces an uncertainty even greater than the one which it avoids. The crystals of salt in the ever-moving tube act as mutual millstones, and gradually wear off one another's

* Ostwald, Z. phys. ch., **34**, 495 (1900).

† For example, see Ostwald's Physicochem. Measurements, Walker (Macmillan, 1894), p. 176.

corners, with the production of fine powder. This fine powder must continually dissolve, because it is more soluble than the larger aggregations. At first it will simply hasten the speed of attaining saturation; but later, when saturation with respect to the larger particles has been attained, the fine powder will tend to produce a solution supersaturated with respect to those larger particles. The experience of Cottrell and others seems to indicate that supersaturation is harder to obviate than inadequate saturation. Cottrell, for example, found that $MnSO_4.H_2O$ attained a concentration of 57.41 grams in 100 grams of water after two hours of agitation when the salt was added to pure water, while after twice as long a time the supersaturation in another tube had only been reduced from 72.5 to 62.3 grams per hundred. The solubility found after 27 hours, when both methods gave the same result, was 58.32, or 0.91 grams more than the first and 4. grams less than the second figure.

The outcome of the matter seems to be that constant results upon solubility are usually obtained only when the rate of production of the fine powder exactly balances the rate at which the supersaturation is relieved, and that constant results thus reached represent only a compromise. With cautious agitation, it is possible that a solubility very near that of flat crystal surfaces might be obtained; on the other hand, very active agitation, such as we used, must tend to increase this solubility almost to that corresponding to the fine powder which we always observed in our tubes.

Every one will agree with Ostwald in deciding that the solution tension of flat surfaces, rather than that of sharply curved surfaces, is the quantity which should be determined, if possible. This result would be best obtained by keeping the solid as free as possible from agitation, and driving a constant current of the saturating solution over these resting crystals. A dissolving apparatus which has recently been described, if assisted by a small turbine and suitably immersed in a thermostat, would perhaps be the safest apparatus, although complete saturation would require much time.*

It is evident, as Ostwald points out, that most published determinations of solubility, those of Cottrell and our own included, are subject to a small uncertainty, but it is also evident that the work of Cottrell is by far the most complete work upon the solubility of manganous sulphate which has been published, and that it wholly overthrows the erroneous results of Linebarger.

* Richards, Am. Chem. Journal, **20**, 189 (1898).

We determined also the solubility of both the dihydrate and the tetrahydrate of the double sulphate of manganese and potassium, and found solutions saturated at 25.0° with both or either hydrate to yield 40.1 grams of anhydrous solid. Hence this temperature must be near the transition temperature of the two hydrates. The detailed publication of these results and many other similar observations must be reserved for a later communication.

In a few words of recapitulation, the present paper may be said to confirm the work of Cottrell and to disprove that of Linebarger, while a measure of doubt is cast upon the usual methods of determining solubility.

CAMBRIDGE, February, 1901.

**Proceedings of the American Academy of Arts and Sciences.**

VOL. XXXVI. No. 29. — JUNE, 1901.

---

RECORDS OF MEETINGS, 1900–1901.

A TABLE OF ATOMIC WEIGHTS. By THEODORE WILLIAM RICHARDS.

REPORT OF THE COUNCIL: BIOGRAPHICAL NOTICES.

CHARLES CARROLL EVERETT. By EPHRAIM EMERTON.

NATHANIEL HOLMES. By JEREMIAH SMITH.

SILAS WHITCOMB HOLMAN. By CHARLES R. CROSS.

SYLVESTER R. KOEHLER. By CHARLES G. LORING.

JOHN ELBRIDGE HUDSON. By JAMES B. THAYER.

JOHN HARRISON BLAKE. By CLARENCE JOHN BLAKE.

CHARLES FRANKLIN DUNBAR. By FRANK WILLIAM TAUSSIG.

OFFICERS AND COMMITTEES FOR 1900–1901.

LIST OF THE FELLOWS AND FOREIGN HONORARY MEMBERS.

STATUTES AND STANDING VOTES.

RUMFORD PREMIUM.

INDEX.

(TITLE-PAGE AND TABLE OF CONTENTS.)

# RECORDS OF MEETINGS.

---

**Nine hundred and seventeenth Meeting.**

MAY 9, 1900. — ANNUAL MEETING.

THE Academy met at the Jefferson Physical Laboratory, Cambridge.

VICE-PRESIDENT TROWBRIDGE in the chair.

A quorum not having been present at the adjourned stated meeting of April 11, 1900, on the motion of the Recording Secretary, it was

*Voted*, That the votes then proposed be now confirmed and approved.

The Corresponding Secretary read letters from Arlo Bates and L. H. Bailey, accepting Fellowship in the Academy. He also read a letter from Seabury C. Mastick, Secretary of the Committee on the Modification of the Federal Legacy Tax, enclosing a new petition intended as a substitute for the one sent out in January and requesting signatures. On the motion of the Recording Secretary, it was

*Voted*, That the President be authorized to sign this petition on behalf of the Academy.

The Chair announced the death of Frederick Edwin Church, Associate Fellow in Class III., Section 4.

The Annual Report of the Council was read by the Corresponding Secretary.*

The Treasurer presented his annual report, of which the following is an abstract: —

* See Proceedings, XXXV. 623.

### General Fund.

*Receipts.*

| | | |
|---|---|---|
| Balance from last year | | $32.61 |
| Investments | $5,649.80 | |
| Assessments | 915.00 | |
| Admission fees | 40.00 | |
| Sale of publications | 71.23 | |
| Miscellaneous | 6.30 | 6,682.33 |
| | | $6,714.94 |

*Expenditures.*

| | | |
|---|---|---|
| General expenses | | $2,499.56 |
| Publishing expenses | | 2,012.73 |
| Library expenses | $1,161.77 | |
| Expenses of moving | 596.78 | |
| Furniture | 184.60 | 1,943.15 |
| Balance | | 259.50 |
| | | $6,714.94 |

### Rumford Fund.

*Receipts.*

| | | |
|---|---|---|
| Balance from last year | | $3,915.10 |
| Investments | $2,566.19 | |
| Sale of publications | 10.00 | |
| Refund of appropriation | 100.00 | |
| Interest on bank account | 71.82 | 2,748.01 |
| | | $6,663.11 |

*Expenditures.*

| | | |
|---|---|---|
| Investigations | $1,215.00 | |
| Medals | 327.00 | |
| Library | 81.28 | |
| Miscellaneous | 10.00 | $1,633.28 |
| Income invested during the year and transferred to capital account | | 3,253.90 |
| Balance | | 1,775.93 |
| | | $6,663.11 |

### Warren Fund.

*Receipts.*

| | | |
|---|---|---|
| Balance from last year | | $1,149.43 |
| Investments | $365.00 | |
| Interest on bank account | 50.27 | 415.27 |
| | | $1,564.70 |

*Expenditures.*

| | | |
|---|---|---|
| Investigations | $500.00 | |
| Accrued interest on bonds purchased | 70.13 | $570.13 |
| Balance | | 994.57 |
| | | $1,564.70 |

BUILDING FUND.

*Receipts.*

| | | |
|---|---|---|
| Balance from last year | | $306.03 |
| Investments | $240.00 | |
| Income | 21.55 | 261.55 |
| | | $567.58 |

*Expenditures.*

| | |
|---|---|
| Accrued interest on bonds purchased | $28.06 |
| Balance | 539.52 |
| | $567.58 |

The following reports were also presented: —

REPORT OF THE RUMFORD COMMITTEE.

At the last Annual Meeting of the Academy, the sum of $1000 was placed at the disposition of the Rumford Committee for the furtherance of researches in light and heat.

The Committee has made the following appropriations from this fund:

October 11, 1899, it was voted that an appropriation of $500 be made to Professor Edwin B. Frost of the Yerkes Observatory, to assist in the construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight.

January 10, 1900, it was voted that an appropriation of five hundred dollars be made to Professor Edward C. Pickering of Harvard College Observatory, for the purpose of carrying out an investigation on the Brightness of Faint Stars by coöperation with certain observatories possessing large telescopes.

Furthermore, on January 10, 1900, the Committee voted to ask the Academy to appropriate one hundred dollars from the income of the Rumford Fund to Professor Theodore W. Richards of Harvard University, for a research on the Transition Point of Crystallized Salts, which request was favorably acted upon by the Academy.

And on April 9, 1900, the Committee voted to ask the Academy to appropriate from the same source the sum of two hundred and fifty

dollars to Mr. Arthur L. Clark of the Worcester Academy in furtherance of a research on the Molecular Properties of Vapors in the Neighborhood of the Critical Point. This recommendation has still to be acted upon.

The attention of the Committee had several times been called to the fact that for a long period of years there had been no way, except by a formal vote of the Academy, in which a person other than a member could purchase a copy of the Life and Works of Count Rumford. Meanwhile occasional applications from reputable persons or libraries had been received. The Committee therefore voted on April 9, 1900, to recommend to the Academy that the Treasurer be authorized to make arrangements for their sale to the public, intending that the whole matter of the manner of sale, price, and other details should be left to his discretion. Such authorization was duly granted by the Academy.

The Committee was furthermore advised that there is no copy of the Life and Works of Count Rumford in the Library of the Academy. It was therefore voted at the meeting of April 9, 1900, to recommend to the Academy that a set be added to the library.

At the same meeting it was voted, that the Committee recommend to the Academy the appropriation of one hundred and fifty dollars from the income of the Rumford Fund for the purchase and binding of the usual periodicals for the current fiscal year, together with the following: Deutsche Zeitschrift für Elektrotechnik, L'Éclairage Électrique, Fortschritte der Elektrotechnik.

It was also voted by the Committee that the Chairman recommend that the usual appropriation of one thousand dollars be made by the Academy for the immediate needs of the Committee in furtherance of research.

I have therefore to present the three last-mentioned recommendations for the consideration of the Academy.

The Committee has considered at much length the subject of an award of the Rumford Premium. Among the various candidates whose claims were discussed, there was one who without dissent was considered in the highest degree worthy of the honor. The numerous researches of Professor Carl Barus in various branches of heat, carried on for many years, have uniformly been characterized by great skill, accuracy, and originality, and these valuable contributions to science are generally recognized as of far-reaching importance.

It was unanimously voted by the Committee, for the first time on January 10, and for the second time on April 9, 1900, to recommend to

the Academy at the Annual Meeting the award of the Rumford Medal to Professor Carl Barus, of Brown University, for his various researches in heat.

In response to the usual request, the Chairman of the Committee has received reports of progress from the following persons to whom grants have been made from the Rumford Fund: Professors H. Crew, E. B. Frost, G. E. Hale, E. H. Hall, F. A. Laws, E. L. Nichols, E. C. Pickering, B. O. Peirce, T. W. Richards, and W. C. Sabine.

These reports in full or in abstract are presented as an appendix to this Report.

CHAS. R. CROSS,
*Chairman of the Rumford Committee.*

## APPENDIX.

### REPORTS OF PROGRESS TO THE RUMFORD COMMITTEE.
### May, 1900.

### PROFESSOR HENRY CREW.

Grants of October 26, 1896, $400, for researches on the electrical, chemical, and thermal effects of the electric arc, and May 3, 1899, $200, for researches on the spectrum of the electric arc.

Referring to an "air-tight arc" which he has constructed, Professor Crew says, "This apparatus is well made, and works in a thoroughly satisfactory manner. With it I have made several series of photographs of the arc spectra of iron and magnesium, in an atmosphere of pure hydrogen. These plates I am now measuring up, and hope to be able to publish the results during the coming summer.

"Contrary to expectations, I do not find the iron spectrum at all simplified by the introduction of hydrogen. For while many lines are blotted out, many new ones are introduced by the hydrogen. No less than sixty-two iron lines, either new or profoundly modified, make their appearance between $\lambda$ 2753 and $\lambda$ 4415. The origin of these lines I have not yet succeeded in finding.

"I have spent some time also in trying to produce, in this arc, the hydrogen series discovered by Professor Pickering in the star Z Puppis; but I have not found anything resembling such a series."

### PROFESSOR EDWIN B. FROST.

Grant of January 10, 1900, $500, to assist in the construction of a spectrograph, especially designed for the measurement of stellar velocities in the line of sight.

"In reply to your inquiry 'as to the present status of researches now in progress which have received aid from the Rumford Fund,' I would state that three remarkably fine prisms have already been purchased, and the other optical parts have been ordered, for the new spectrograph designed for the determination of stellar velocities in the line of sight, in aid of which research a grant of $500 was made last autumn.

"It is hoped that the spectrograph may be completed and the regular work with the instrument may be begun during the present summer, and I shall therefore expect to be able to announce some results of the investigations for your next annual meeting."

### PROFESSOR GEORGE E. HALE.

Grant of November 10, 1897, $400, for the purpose of completing a spectroheliograph.

"The spectroheliograph was first attached to the 40-inch telescope last December. Preliminary tests in the laboratory had shown it to be extremely satisfactory from an optical point of view, at least in so far as the definition and contrast of the photographs of spectra were concerned. As we were without a skilled instrument maker at the observatory for several months last summer and autumn, I had the moving plate holder and second slit constructed by an instrument maker in Chicago. The first tests with the telescope showed the presence of a mechanical defect, which caused the plates to be striped with lines a millimeter apart, the pitch of the screw which drives the plate-carriage. A series of experiments showed that these lines were due in large part, if not altogether, to the absence of suitable end-thrust bearings for the screw, and to the poor construction of the screw, nut, plate-carriage, etc. It was then decided to completely reconstruct this part of the spectroheliograph in our own shop. End-thrust bearings were supplied, together with a new screw, which was carefully ground. As the result of the work the millimeter lines did not appear on the photographs taken after the change had been made. It was found, however, that the plate was still covered with fine lines about one quarter of a millimeter apart. These are shown on the plate which I will send you in a few days. In order to remove these lines a large number of experiments were required, but at last, plates practically free from lines, and even smoother than those obtained with the very satisfactory hydraulic apparatus of the Kenwood spectroheliograph, were secured. The diffi-

culty was due in part to errors in the gears, and in part to the theoretically correct double Hooke's joint, which has now been replaced with a belt and pulleys.

"As may easily be imagined, the curvature of the spectral lines in this spectroheliograph is very marked. If the first slit is straight the second slit must be curved, to fit the K line, and the resulting image of the sun is seriously distorted. By dividing the curvature equally between the two slits, and moving the plate in a direction opposite to that employed with a straight first slit, the distortion can be wholly removed. You will notice that the images on the plate sent you are round.

"As soon as the eclipse work is over I hope to return to the spectroheliograph. The preliminary results are such as to lead me to expect much from the instrument."

### PROFESSOR EDWIN H. HALL.

Grant of April 26, 1895, $250, in aid of his investigation on the thermal conductivity of metals.

"I expect to read by title a paper at the next meeting of the Academy. I am using some of the money on a side research carried on by Mr. McElfresh, a graduate student, on the thermo-electric effect of hydrogen occluded in nickel. Said effect seems thus far to be lacking."

### PROFESSOR FRANK A. LAWS.

Grant of December 13, 1893, in aid of an investigation on the thermal conductivity of metals.

"In respect to the experiments on Thermal Conductivity I can say that this constant for the cast-iron specimen has been determined, and the result calculated. I have not published the method, for the calibration is not satisfactory to me on account of a very peculiar set of readings which I do not feel justified in rejecting. During the examination period I hope to straighten the matter out."

### PROFESSOR EDWARD L. NICHOLS.

Grant of October 19, 1894, $250, in aid of investigations on the radiations from carbon at different temperatures.

"I beg to report that my investigation of the visible radiation from carbon, made in part by the aid received from the Rumford Fund, is nearing completion. Spectrophotometric comparisons of the light from

the two varieties of carbon, black and gray, using as a standard the acetylene flame, have been made up to temperatures above 1600°. I am at present struggling with the more difficult range between 1600° and the melting point of platinum. The determination of the higher temperatures offers considerable difficulty as yet, but there are indications which make it seem worth while to carry the investigation to as high a point as possible. The research involves three subordinate investigations, one of which, on the temperatures of the acetylene flame itself, is completed. This I have made the subject of a paper read before the Physical Society. It is likewise printed in the April number of the Physical Review. In my report to the American Academy, I shall incorporate the results of these measurements in connection with the main subject. Of the other two subordinate researches, the study of the thermo elements employed is nearly completed, and a determination of the distribution of energy in the spectrum of the acetylene flame by means of the Nichols radiometer is in progress. The latter is being carried on by one of my assistants, Mr. G. W. Stewart, and we hope as a result of his measurements to obtain a study of the absolute values, by means of which spectrophotometric measurements for different wave lengths can be brought into known relations to each other.

"The work for which the grant was made from the Rumford Fund has required a much longer time than I anticipated, but in spite of the numerous difficulties which we have had to overcome, I think the end is now in sight."

### PROFESSOR EDWARD C. PICKERING.

Grant of January 10, 1900, $500 for the purpose of carrying out an investigation on the Brightness of Faint Stars, by coöperation with certain observatories possessing large telescopes.

"An appropriation of five hundred dollars ($500) has been made from the Rumford Fund, to be expended under the direction of Professor Pickering, for the purpose of carrying out an investigation on the brightness of faint stars by coöperation with certain observatories possessing large telescopes. This appropriation results from a communication made to the Council of the American Astronomical and Astro-physical Society held in New York last January. It was represented that the most urgent need of astronomy in America was adequate endowment of the great telescopes of the country so that they could be kept actively at work. It was shown that while the two largest telescopes of the country, and of the world, were kept constantly at work, the means for

the reduction and publication of the observations are wholly inadequate; while some of the largest telescopes in the country, representing a plant costing hundreds of thousands of dollars, are nearly idle and therefore useless. Observations of the greatest value can be obtained with these instruments at small expense, and it is hoped that the beginning now made will justify its permanent continuance on a large scale. The problem undertaken is the determination of the light of faint stars, selected as standards. These will furnish points of reference to which other photometric measures may be referred. Five photometers have been constructed in which, by interposing a photographic wedge of shade glass, an artificial star is reduced in brightness until it appears equal to a real star, as seen in a large telescope. Thirty-six regions have been selected in different parts of the sky, in each of which a series of standards is to be measured. Five stars of about the twelfth magnitude, five of the fifteenth, five of the sixteenth, and five of the seventeenth are to be chosen in each of these regions. The faintest stars will be selected and measured with the Yerkes 40-inch and Lick 36-inch telescopes. Those of the sixteenth magnitude will be measured with the 26-inch telescope of the University of Virginia and perhaps the Princeton 23-inch telescope. The stars of the fifteenth magnitude will be measured with the 15-inch Harvard telescope. All of these stars will be compared with the stars of the twelfth magnitude, when absolute magnitudes will be determined with the 12-inch Harvard meridian photometer. Their relative brightness will also be determined more accurately with the Harvard 15-inch telescope. After the work is fairly started it is believed that it can be reduced to a simple routine, by which great results may be attained with a moderate expenditure. By the time this report is presented, it is expected that observations with the Yerkes, Lick, University of Virginia, and Harvard telescopes will be in progress."

PROFESSOR B. O. PEIRCE.

Grant of December 2, 1892, $200, and April 26, 1895, in aid of an investigation on the propagation of heat in certain solid bodies.

Professor Peirce writes that he "published last summer in the Proceedings of the Academy a short paper on the 'Thermal Conductivity of Vulcanite,' giving therein the results of a long series of experiments. This paper in a somewhat extended form appeared in the Philosophical Magazine."

A paper on the specific heats of different marbles is also ready for publication.

### PROFESSOR THEODORE W. RICHARDS.

Grants of October 12, 1898, $200, for the construction of a microkinetoscope, the immediate application of which is to be a study of the birth and growth of crystals; and January 10, 1900, $100, for a research on the transition point of crystallized salts.

"I have had the honor of receiving two grants from the Rumford Fund, the accounts of which have not been closed.

"The first was given for the study of crystal growth by instantaneous photography. Upon this research I have already made several reports. Having pushed the photographic study of the growth of crystals in aqueous solutions to the furthest limit which seemed possible without a very much greater expenditure of money, we have turned our attention to the study of the change of the crystalline structure of iron and steel at a red heat. We have been able so to modify our apparatus, with very slight extra expenditure, that such study seems to be possible.

"The second grant of money was for prosecuting a research on new fixed temperatures for thermometric standardization. Of this grant only $27.50 have thus far been spent for materials which have not yet been exhausted. We have succeeded in showing that the transition temperature of sodic chromate is very near 19.88°, but the exact point cannot be fixed until our thermometers have arrived from the Bureau internationale. These new thermometers are to be the property of the College, hence all the remainder of the Rumford grant ($100 — $27.50 = $72.50) will be available for the special purposes of this particular investigation."

### PROFESSOR WALLACE C. SABINE.

Grants of January 12, 1898, $400, and March 15, 1899, $200, for researches on ultra-violet radiation.

Professor Sabine states that Mr. Lyman, who is engaged upon the investigation, "will publish a paper on a by-product of the investigation which seems to me very interesting and important. In this paper he proposes to show that among the spectra formed by the Rowland concave gratings there are spectra not accounted for by the ordinary theory of the grating; that such spectra are common, and at times fairly strong and of excellent definition; that these spectra are diffraction spectra of much less dispersion than the ordinary recognized spectra, and that the errors of ruling to which they are due are not local but general to the whole surface of the grating He will also explain an experimental method of sorting out these lines from the regular and calculable spectra.

These false spectra are especially dangerous in series spectra work, giving a somewhat systematic reproduction of strong lines and groups, which in actual vibration frequencies do not exist. There is some evidence that such errors have been committed in the past, and it was in the presence of such errors that the false spectra were here discovered."

## Report of the C. M. Warren Committee.

In behalf of the C. M. Warren Committee, I have to report that Professor Mabery, to whom a grant of $500 was voted by the Academy at the last Annual Meeting, has vigorously prosecuted his researches on the Composition of Petroleums. During the year he has published also several papers describing the results of his earlier researches which were aided by previous grants from the Warren Fund.

Professor H. O. Hofman, to whom grants, amounting in all to $230, were made several years ago, has in this year published the results of his work in a memoir entitled "The Temperatures at which Certain Ferrous and Calcic Silicates are formed in Fusion, and the Effect upon these Temperatures of the Presence of Certain Metallic Oxides."

The C. M. Warren Committee recommends that the sum of six hundred dollars ($600) from the income of the Cyrus M. Warren Fund be granted to Professor Charles F. Mabery, of Cleveland, Ohio, for the continuation of his researches on the Chemistry of Petroleums.

F. H. Storer, *Chairman.*

9 May, 1900.

## Report of the Committee of Publication.

The Publishing Committee reports that during the past academic year there have been issued three numbers of Vol. XXXIV. and twenty-two numbers of Vol. XXXV. of the Proceedings, aggregating 579 pages, with no plates. One number only has been printed at the charge of the Rumford Fund. The expenditure from the General Fund was $2,012.93, out of an available amount from appropriation and sales of $2,471.23, leaving an unexpended balance of $458.30. The Committee desires for the coming year the same appropriation as for the last, viz., $2,400.

For the Committee,

Samuel H. Scudder, *Chairman.*

## Report of the Committee on the Library.

The most important feature of the year was the removal of the Library from the Boston Athenæum building to the third story of the new building of the Massachusetts Historical Society. Although it was expected that these quarters would be ready in April, 1899, it was six months later before they could be occupied. The books, etc., were moved in good order between October 17 and November 7, 1899, thanks to the careful supervision of Dr. Holden, the Assistant Librarian. The opportunity was taken to send to the binder many volumes which had accumulated from previous years. The storage-room in the basement of the new building could not be occupied until April, 1900, and during the first week of that month the publications of the Academy, which had been stored in the basement of the Athenæum, were brought there.

The accessions during the year have been as follows: —

| | Vols. | Parts of vols. | Pams. | Maps. | Total. |
|---|---|---|---|---|---|
| By gift and exchange | 431 | 1687 | 328 | 5 | 2451 |
| By purchase — Gen'l Fund | 25 | 593 | | | 618 |
| By purchase — Rumf. Fund | | 155 | | | 155 |
| Total | 456 | 2435 | 328 | 5 | 3224 |

The total number compares with 3284 during the previous year.

25 volumes and 593 parts of volumes were bought with the appropriation from the income of the General Fund at an expense of $191.35. 155 parts of volumes were bought with an appropriation from the income of the Rumford Fund for $24.28.

449 volumes were bound at an expense of $504.55, of which $487.00 was charged to the General Fund, and $17.05 to the Rumford Fund.

202 books have been borrowed by twenty-five persons, including eighteen Fellows of the Academy. 155 of these volumes were borrowed between May and October, 1899, and only 47 between November, 1899, and May, 1900. 22 volumes were not returned before May 2nd, in accordance with the rule. It will be noticed that the use of the Library has much diminished during the past six months. During the preceding year 235 volumes were borrowed.

Of the appropriation from the General Fund of $1500, $1161.77 has been spent. This includes $479.74 for incidental expenses of the Assistant Librarian, but does not include about $200 for subscriptions to periodicals not yet paid and about $100 for books now in binders' hands. It

is therefore hoped that the unexpended balance of the $1500, viz. $338.23, may be reappropriated for next year, making a total of $1838.23.

The appropriation from the Rumford Fund was $120, of which only $41.33 has been spent, $17.05 for binding and $24.28 for periodicals, but subscriptions to periodicals aggregating about $65, and some binding must still be paid for. Therefore it is desired that the balance of the appropriation, viz. $78.67, be reappropriated for next year in addition to the $150 recommended by the Rumford Committee. The volumes needed to complete the file of the "Fortschritte der Physik," which it was voted to purchase, have been ordered.

The cost of moving the Library and belongings, which it was voted to pay from the funds of the Academy, was $601.78.

Of the special appropriation of $200 for furnishing the Library, $184.60 has been spent. This includes $30 for the purchase of a typewriter which has been useful to the Recording Secretary as well as to the Assistant Librarian.

In conclusion, the need of a new catalogue of the Library is urged. At present there is only an author-catalogue written on inconveniently large cards, and the writing is often nearly illegible. So valuable a library demands a modern catalogue of authors and subjects, either typewritten or printed on standard cards. The cost of such a catalogue is not known, but a special appropriation of $200 is asked for, to commence the work.

A. Lawrence Rotch,
*Librarian, and Chairman Committee on the Library.*

Boston, May 9, 1900.

In accordance with the recommendations contained in the above reports, it was

*Voted*, To award the Rumford Medal to Carl Barus, for his various researches in heat.

*Voted*, That a set of the Life and Works of Count Rumford be added to the Library of the Academy.

*Voted*, To appropriate one hundred and fifty dollars ($150) from the income of the Rumford Fund for the purchase and binding of the usual periodicals for the current fiscal year, together with the following: Deutsche Zeitschrift für Elektrotechnik, L'Éclairage Électrique, and Fortschritte der Physik.

*Voted*, That the sum of one thousand dollars ($1000) from

the income of the Rumford Fund be placed at the disposal of the Rumford Committee to be expended in aid of investigations on light and heat, payments to be made on the order of the Chairman of the Committee.

*Voted*, That an appropriation of six hundred dollars ($600) from the income of the Warren Fund be granted to Charles F. Mabery of Cleveland, Ohio, for the continuation of his researches on the chemistry of petroleum.

*Voted*, To appropriate twenty-four hundred dollars ($2400) from the income of the General Fund for the expenses of publication.

*Voted*, To appropriate eighteen hundred and thirty-eight and $\frac{23}{100}$ dollars ($1838.23) from the income of the General Fund and two hundred and twenty-eight and $\frac{67}{100}$ dollars ($228.67) from the income of the Rumford Fund, in addition to the amount recommended by the Rumford Committee, for library expenses.

*Voted*, to appropriate two hundred dollars ($200) toward making a new catalogue of the Library.

On the recommendation of the Committee of Finance, it was

*Voted*, To appropriate two thousand dollars ($2000) from the income of the General Fund for general expenses.

*Voted*, That the assessment for the ensuing year be five dollars.

On the motion of S. H. Scudder, it was

*Voted*, To meet on adjournment on the second Wednesday in June.

The annual election resulted in the choice of the following officers and committees: —

ALEXANDER AGASSIZ, *President.*
JOHN TROWBRIDGE, *Vice-President for Class I.*
ALPHEUS HYATT, *Vice-President for Class II.*
AUGUSTUS LOWELL, *Vice-President for Class III.*
WILLIAM M. DAVIS, *Corresponding Secretary.*
WILLIAM WATSON, *Recording Secretary.*
FRANCIS BLAKE, *Treasurer.*
A. LAWRENCE ROTCH, *Librarian.*

*Councillors.*

HENRY TABER,
THEODORE W. RICHARDS, } of Class I.
HARRY M. GOODWIN,

WILLIAM T. COUNCILMAN,
JOHN E. WOLFF, } of Class II.
GEORGE H. PARKER,

JAMES B. AMES,
WILLIAM EVERETT, } of Class III.
A. LAWRENCE LOWELL,

*Member of the Committee of Finance.*

AUGUSTUS LOWELL.

*Rumford Committee.*

ERASMUS D. LEAVITT, AMOS E. DOLBEAR,
EDWARD C. PICKERING, ARTHUR G. WEBSTER,
CHARLES R. CROSS, THEODORE W. RICHARDS,
THOMAS C. MENDENHALL.

*C. M. Warren Committee.*

CHARLES L. JACKSON, LEONARD P. KINNICUTT,
SAMUEL CABOT, ARTHUR M. COMEY,
HENRY B. HILL, ROBERT H. RICHARDS,
HENRY P. TALBOT.

The following gentlemen were elected members of the Academy: —

Jay Backus Woodworth, of Cambridge, as Resident Fellow in Class II., Section 1 (Geology, Mineralogy, and Physics of the Globe.)

Merritt Lyndon Fernald, of Cambridge, as Resident Fellow in Class II., Section 2 (Botany).

William Ernest Castle, of Cambridge, as Resident Fellow in Class II., Section 3 (Zoölogy and Physiology).

George Mercer Dawson, of Ottawa, as Associate Fellow in Class II., Section 1 (Geology, Mineralogy, and Physics of the Globe), in place of the late Sir John William Dawson.

Melville Weston Fuller, of Washington, as Associate Fellow in Class III., Section 1 (Philosophy and Jurisprudence).

Rufus Byam Richardson, of Athens, as Associate Fellow in Class III., Section 2 (Philology and Archaeology).

Thomas Day Seymour, of New Haven, as Associate Fellow in Class III., Section 2.

Henry Morse Stephens, of Ithaca, as Associate Fellow in Class III., Section 3 (Political Economy and History).

William Cawthorne Unwin, of London, as Foreign Honorary member in Class I., Section 4 (Technology and Engineering).

Sir Archibald Geikie, of London, as Foreign Honorary Member in Class II., Section 1 (Geology, Mineralogy, and Physics of the Globe), in place of the late Carl Friedrich Rammelsberg.

Sir John Murray, of Edinburgh, as Foreign Honorary Member in Class II., Section 1, in place of the late Alfred Louis Olivier Legrand Des Cloizeaux.

Arthur G. Webster called attention to the bill before the House of Representatives for the establishment of a National Standardizing Bureau, and on his motion, it was

*Voted*, That the Academy approves this project.

On the motion of W. M. Davis, it was

*Voted*, That the committee appointed at the meeting of April 11, 1900, to consider the propriety of amending the first chapter of the Statutes be instructed to correct certain clerical errors in the Statutes.

Clarence J. Blake made some remarks on the scientific researches of his father, the late John H. Blake, which he intended to describe more fully in a forthcoming biographical notice.

John Trowbridge described some results obtained with a storage battery of twenty thousand cells and exhibited the battery in operation.

Experiments on the passage of powerful discharges through minute orifices were described, and proofs of the oscillatory nature of sparks six feet long were given. Since these sparks closely represent the main features of lightning, it is probable that most lightning discharges are also oscillatory. The battery with the aid of large condensers furnishes

powerful quantity discharges which are more interesting from a scientific point of view than discharges of high electromotive force; for a new field appears to be opened in spectrum analysis. Photographs of the spectra of gases can be obtained with one or two discharges with a narrow slit.

Perhaps the most interesting results obtained with the battery were from the methods of exciting the X-rays. Photographs of the usual subjects treated by these rays can be taken, and they exhibit great contrasts; moreover, there are traces of ligaments and muscles as well as bones. The members of the Academy visited the battery room and saw a hydrogen tube excited by the discharge from three hundred Leyden jars, and the lighting of an X-ray tube.

The following papers were presented by title: —

Paleontological Notes V. A New Fossil Crab from the Miocene Greensand Bed of Gay Head, Martha's Vineyard, with Remarks on the Phylogeny of the Genus Cancer. By Alpheus S. Packard.

On the Thermal Diffusivities of Different Kinds of Marble. By B. O. Peirce and R. W. Willson.

Paleontological Notes VI. On Supposed Merostomatous and Other Paleozoic Arthropod Trails, with Notes on those of Limulus. By Alpheus S. Packard.

On the Continuity of Groups generated by Infinitesimal Transformations. By S. E. Slocum. Presented by Henry Taber.

On the Thermal and the Electrical Conductivity of Soft Iron. By Edwin H. Hall.

An Apparatus for Recording Alternating Current Waves. By Frank A. Laws.

The Dinitro Compounds of Paradibrombenzol. By C. Loring Jackson and D. F. Calhane.

On Certain Derivatives of Orthobenzoquinone. By C. Loring Jackson and Waldemar Koch.

Geometry on Ruled Quartic Surfaces. By F. B. Williams. Presented by W. E. Story.

On the Action of Sodic Sulphite on Tribromdinitrobenzol and Tribromtrinitrobenzol. By C. Loring Jackson and Richard B. Earle.

**Nine hundred and eighteenth meeting.**

JUNE 13, 1900. — ADJOURNED ANNUAL MEETING.

A quorum was not present and the Academy was not called to order.

**Nine hundred and eighteenth Meeting.**

OCTOBER 10, 1900. — STATED MEETING.

The CORRESPONDING SECRETARY in the chair.

The following letter was read: —

843 EXCHANGE BUILDING, BOSTON,
September 5, 1900.

FRANCIS BLAKE, ESQ.,
*Treasurer of the American Academy of Arts and Sciences.*

DEAR SIR, — By a letter enclosed in his will, my Father, Mr. Augustus Lowell, requested his sons to pay "to the American Academy of Arts and Sciences $10,000." It gives me great pleasure to enclose to you, in accordance with this request, a check for the amount named.

Very truly yours,
A. LAWRENCE LOWELL.

The Corresponding Secretary also read letters from W. E. Castle, M. L. Fernald, Jeremiah Smith, and J. B. Woodworth, accepting Fellowship; from George M. Dawson, M. W. Fuller, T. D. Seymour, and H. M. Stephens, accepting Associate Fellowship; and from Sir Archibald Geikie, F. Kohlrausch, Sir John Murray, and W. C. Unwin, acknowledging election as Foreign Honorary Members.

Announcement was received of the death of D. T. Day, formerly President of the Buffalo Society of Natural Sciences.

The following deaths were announced: —

Augustus Lowell, Vice-President for Class III.; John Elbridge Hudson, of Class III., Section 1., Sylvester R. Koehler, of Class III., Section 4, Resident Fellows; James Edward Keeler, of Class I., Section 1, Jacob Mandes DaCosta, and Alfred Stillé, of Class II., Section 4, William Mitchell, of Class III., Section 1, Associate Fellows; Willy Kühne, of Class II., Section 4, Charles Russell, Baron Russell of Killowen, and Henry Sidgwick, of Class III., Section 1, Foreign Honorary Members.

The Chair appointed the following standing committees: —

*Committee of Publication.*

SAMUEL H. SCUDDER, SETH C. CHANDLER,
CRAWFORD H. TOY.

*Committee on the Library.*

A. LAWRENCE ROTCH, HENRY W. HAYNES,
SAMUEL HENSHAW.

*Auditing Committee.*

HENRY G. DENNY, WILLIAM L. RICHARDSON.

The Chair appointed from the next retiring Councillors

THEODORE W. RICHARDS, of Class I.,
WILLIAM T. COUNCILMAN, of Class II.,
JAMES B. AMES, of Class III.,

a committee to nominate candidates for the offices made vacant by the death of Augustus Lowell.

Thomas Messenger Drown, of South Bethlehem, was elected an Associate Fellow in Class I., Section 3 (Chemistry).

J. H. Wright gave an account of "Recent Excavations in Crete," by Miss Helen S. Boyd, of the American School at Athens.

Barrett Wendell read an essay on the "Literary History of America."

W. M. Davis presented some "Geographical Notes on Brittany and Devonshire."

The following paper was presented by title by W. C. Sabine: —

False spectra from the Rowland Concave Grating. By Theodore Lyman.

**Nine hundred and nineteenth Meeting.**

NOVEMBER 14, 1900.

The CORRESPONDING SECRETARY in the chair.

The Corresponding Secretary read a letter from the American Chemical Society transmitting resolutions relative to the establishment of a National Standards Bureau in connection

with the United States Office of Standard Weights and Measures and requesting coöperation in its efforts to secure the establishment of such bureau.

On the motion of Arthur G. Webster, it was

*Voted*, That this matter be referred to a committee to be appointed by the Chair.

The committee was constituted as follows: —

JAMES M. CRAFTS, *Chairman*,
ARTHUR G. WEBSTER,
THEODORE W. RICHARDS,
EDWIN H. HALL.

On the motion of Barrett Wendell, the following resolution was adopted: —

*Whereas*, The Academy has received the sum of ten thousand dollars paid by the sons of the late Augustus Lowell at the request of their father, therefore be it

*Resolved*, That the Academy accepts this gift with grateful appreciation of the generosity of its late honored Vice-President, and that the Corresponding Secretary notify this action to Mr. Lowell's sons.

The following papers were presented by title: —

On the Composition of California Petroleum. By Charles F. Mabery and Edward J. Hudson.

On the Chlorine Derivatives of the Hydrocarbons in California Petroleum. By Charles F. Mabery and Otto J. Sieplein.

On the Composition of Japanese Petroleum. By Charles F. Mabery and Shinichi Takano.

James Ford Rhodes read an account of "Sherman's March to the Sea," of which the following is an abstract: —

After the capture of Atlanta, the question in Sherman's mind was how he should still further proceed on the offensive. Hood gave him trouble by severing his communications, but he could not be brought to a battle, nor could he be caught in a pursuit. Sherman resolved to leave Tennessee in the care of Thomas and march through Georgia to the sea. He severed his communications with the North, November 12, 1864, and from that day to December 14 no direct intelligence from him

reached the North. There was little fighting, but the supply of 62,000 troops in the enemy's country called for foresight and system on the part of the general; to prevent the host from degenerating into a lawless mob required the enforcement of discipline by the general and his officers. The army foraged liberally on the country in an orderly manner. While there were some abuses, some wanton destruction of property, and some pillage, there were no cases of murder or rape. On the whole the army behaved as well as could have been expected. Sherman estimated the damage done to the State of Georgia at $100,000,000. On the night of December 20, 1864, the Confederates evacuated Savannah, Sherman took possession of the city, and sent his celebrated Christmas-gift despatch to President Lincoln.

H. Helm Clayton read a paper entitled: "The Eclipse Cyclone and the Diurnal Cyclone: Results of Meteorological Observations during the Solar Eclipse of May 28, 1900."

**Nine hundred and twentieth Meeting.**

DECEMBER 12, 1900.

The Academy met at the house of William W. Jacques.

The PRESIDENT in the chair.

The death of Thomas Gaffield, Resident Fellow in Class I., Section 3, was announced.

On the motion of the Corresponding Secretary, it was

*Voted*, That a committee be appointed to make revision of certain passages in the Statutes and report thereon to the Academy.

This committee was constituted as follows: —

The PRESIDENT,
The CORRESPONDING SECRETARY,
C. LORING JACKSON.

Wallace C. Sabine spoke on "The Influence of Architecture on Melody and the Development of the Musical Scale."

John E. Wolff described the celebration of the two-hundredth anniversary of the foundation of the Royal Academy of Sciences, at Berlin, on the 19th and 20th of March last, which John W. White and himself attended as delegates from the American Academy.

William Everett gave an account of the life and works of the late Henry Sidgwick, referring particularly to his eminent ability and estimable character.

The following paper was read by title: —

"Symmetrical Triiodbenzol." By C. Loring Jackson and G. E. Behr.

**Nine hundred and twenty-first Meeting.**

JANUARY 9, 1901. — STATED MEETING.

VICE-PRESIDENT HYATT in the chair.

On the motion of C. L. Jackson, it was

*Voted*, To defer action on the proposed amendments of the Statutes.

*Voted*, That the Academy send a message of congratulation to Vladimir Markovnikoff, of Moscow, on the occasion of the 40th anniversary of his work on chemistry.

The vacancies occasioned by the death of Augustus Lowell were filled by the election of

JAMES B. THAYER, *Vice-President for Class III.*

ELIOT C. CLARKE, *Member of the Committee of Finance.*

Denman W. Ross read a paper entitled, "Design as a Science."

S. C. Chandler gave an account of his "New Discovery concerning the Motion of the Earth's Pole."

The following papers were presented by title: —

"Suggestion concerning the Nomenclature of Heat Capacity." By T. W. Richards.

"A Study of Growing Crystals by Instantaneous Photomicrography." By T. W. Richards and E. H. Archibald.

**Nine hundred and twenty-second Meeting.**

FEBRUARY 13, 1901.

The CORRESPONDING SECRETARY in the chair.

The Chair announced the death of Charles Hermite, Foreign Honorary Member in Class I., Section 1.

An invitation to the Ninth Jubilee Celebration of the University of Glasgow was read. On the motion of the Recording Secretary, it was

*Voted*, That the Academy send delegates to this celebration.

A circular inviting attendance at the Fifth International Congress of Physiologists was read; also, a letter from James B. Thayer, acknowledging his election as Vice-President for Class III.

The following paper was read by title: —

"A Study of Variation in the Fiddler Crab (Gelasimus pugilator Latr.)" By Robert M. Yerkes. A Contribution from the Zoölogical Laboratory of the Museum of Comparative Zoölogy at Harvard College. Presented by E. L. Mark.

**Nine hundred and twenty-third Meeting.**

MARCH 13, 1901. — STATED MEETING.

VICE-PRESIDENT HYATT in the chair.

The following deaths were announced: —

Charles Carroll Everett, Resident Fellow in Class III., Section 1.

George Mercer Dawson, Associate Fellow in Class II., Section 1.

The following gentlemen were elected members of the Academy: —

Alexander Wilmer Duff, of Worcester, as Resident Fellow in Class I., Section 2 (Physics).

Theodore Lyman, of Brookline, as Resident Fellow in Class I., Section 2.

Lewis Jerome Johnson, of Cambridge, as Resident Fellow in Class I., Section 4 (Technology and Engineering).

Henry Lloyd Smyth, of Cambridge, as Resident Fellow in Class I., Section 4.

Frank Shipley Collins, of Malden, as Resident Fellow in Class II., Section 2 (Botany).

Ephraim Emerton, of Cambridge, as Resident Fellow in Class III., Section 3 (Political Economy and History).

Frank William Taussig, of Cambridge, as Resident Fellow in Class III., Section 3.

Eliakim Hastings Moore, of Chicago, as Associate Fellow in Class I., Section 1 (Mathematics and Astronomy).

George Ellery Hale, of Williams Bay, as Associate Fellow in Class I., Section 2 (Physics).

Edward Leamington Nichols, of Ithaca, as Associate Fellow in Class I., Section 2, in place of the late William Augustus Rogers.

Cyrus Guernsey Pringle, of Charlotte, Vermont, as Associate Fellow in Class II., Section 2 (Botany), in place of the late George Clinton Swallow.

Franklin Paine Mall, of Baltimore, as Associate Fellow in Class II., Section 3 (Zoölogy and Physiology), in place of the late Alfred Stillé.

Henry Fairfield Osborn, of New York, as Associate Fellow in Class II., Section 3, in place of the late Othniel Charles Marsh.

Charles Otis Whitman, of Chicago, as Associate Fellow in Class II., Section 3.

William Stewart Halsted, of Baltimore, as Associate Fellow in Class II., Section 4 (Medicine and Surgery), in place of the late William Alexander Hammond.

William Williams Keen, of Philadelphia, as Associate Fellow in Class II., Section 4, in place of the late Jacob Mendes Da-Costa.

Jules Henri Poincaré, of Paris, as Foreign Honorary Member in Class I., Section 1 (Mathematics and Astronomy), in place of the late Francesco Brioschi.

Heinrich Müller-Breslau, of Berlin, as Foreign Honorary Member in Class I., Section 4 (Technology and Engineering).

Hugo Kronecker, of Bern, as Foreign Honorary Member in Class II., Section 3 (Zoölogy and Physiology), in place of the late Willy Kühne.

Sir Thomas Lauder Brunton, of London, as Foreign Honorary Member in Class II., Section 4 (Medicine and Surgery), in place of the late Sir James Paget, Bart.

Robert Koch, of Berlin, as Foreign Honorary Member in Class II., Section 4, in place of the late Louis Pasteur.

Albert Venn Dicey, of Oxford, as Foreign Honorary Member in Class III., Section 1 (Philosophy and Jurisprudence).

William Edward Hearn, of Melbourne, as Foreign Honorary

Member in Class III., Section 1, in place of the late Charles Russell, Baron Russell of Killowen.

Henry Jackson, of Cambridge, as Foreign Honorary Member in Class III., Section 2 (Philology and Archaeology), in place of the late Henry Sidgwick.

Edmondo de Amicis, of Florence, as Foreign Honorary Member in Class III., Section 4 (Literature and the Fine Arts), in place of the late John Ruskin.

On the motion of the Corresponding Secretary, it was

*Voted*, To meet, on adjournment, on the 10th of April next.

B. L. Robinson gave an account of "Recent Advances in the General Classification of the Flowering Plants."

R. T. Jackson spoke on "Resorption as a Factor in Growth."

The following papers were presented by title: —

The Occlusion of Magnesic Oxalate by Calcic Oxalate, and the Solubility of Calcic Oxalate. By Theodore W. Richards, Charles F. McCaffrey, and Harold Bisbee.

Contributions from the Cryptogamic Laboratory of Harvard University, XLVI. Preliminary Diagnoses of New Species of Laboulbeniaceae, III. By Roland Thaxter.

The Development and Function of Reissner's Fibre and its Cellular Connections. By Porter E. Sargent. Presented by E. L. Mark.

The Solubility of Manganous Sulphate. By Theodore W. Richards and F. R. Fraprie.

Contributions from the Gray Herbarium of Harvard University. New Series, No. XX. I. Synopsis of the genus Melampodium. II. Synopsis of the genus Nocca. III. New Species and Newly Noted Synonymy among the Spermatophytes of Mexico and Central America. By B. L. Robinson.

Contributions from the Gray Herbarium of Harvard University. New Series, No. XXI. By M. L. Fernald. Some New Spermatophytes from Mexico and Central America.

**Nine hundred and twenty-fourth Meeting.**

APRIL 10, 1901. — ADJOURNED STATED MEETING.

VICE-PRESIDENT TROWBRIDGE in the chair.

The Corresponding Secretary read letters from L. J. Johnson, Theodore Lyman, H. L. Smyth, and F. W. Taussig, accepting Fellowship; and from W. S. Halsted, W. W. Keen, Franklin P. Mall, E. H. Moore, Edw. L. Nichols, and Henry F. Osborn, acknowledging election as Associate Fellows.

The chair announced the following deaths: —

Edward Elbridge Salisbury, of New Haven, Associate Fellow in Class III., Section 2.

Jacob Georg Agardh, of Lund, Foreign Honorary Member in Class II., Section 2.

On the recommendation of the Rumford Committee, presented by A. G. Webster, it was

*Voted*, To appropriate from the income of the Rumford Fund the sum of five hundred dollars ($500) to T. W. Richards in aid of a research on the Joule-Thomson experiment on free expansion.

Edwin H. Hall presented "An Exposition of the Theory of Electrons, the Electrical Fragments of Atoms."

The following paper was presented by title: —

The Law of Physico-chemical Change. By Gilbert Newton Lewis. Presented by T. W. Richards.

Dr. W. G. Farlow was appointed Delegate of the Academy to the celebration of the ninth jubilee of the foundation of the University of Glasgow and was charged with the presentation of the address on the following page, signed by the Vice-President of Class III. and the Corresponding Secretary.

VIRO ILLUSTRISSIMO CANCELLARIO
CURIAE SENATUIQUE UNIVERSITATIS GLASGUENSIS
ACADEMIA ARTIUM ET SCIENTIARUM AMERICANA
QUAE EST BOSTONIAE NOV.-ANGLORUM.
S. P. D.

Vix dici potest quanto guadio audiverimus vos in mente habere istam diem celebrare qua Universitas vestra annum quadringentesimum expleverit, ex quo Pontifex ille benevolus nomen ac jura Universitatis concesserit; quis enim ignorat longam illam annorum seriem orbi terrarum perpetuis illuxisse virorum operibus, in omni arte atque in omni scientia praestantissimorum, nomen semper illustre Caledoniae vel ad majus fastigium efferentibus?

Quorum ut neque tempus neque charta sufficeret nominibus tantum percurrendis, nostro officio satisfiat si gratias praecipuas agentes quod ad sollemnia celebranda amicissime invitastis socium nostrum virum ornatissimum Gulielmum Gilson Farlow legaverimus qui istis caeremoniis interfuturus nostram erga vos benevolentiam pro virili parte libentissime praestabit.

Illum ergo, viri illustrissimi, precamur ut benigne excipiatis ut qui amicitiae vincula inter Scotiam Americamque arctiora dignissime ligaverit.

Dabamus Bostoniae Nov.-Anglorum A. D. Non: Maias anno salutis MCMI, atque Rerumpublicarum Foederatarum libertatis vindicatae CXXV.

# A TABLE OF ATOMIC WEIGHTS

## OF SEVENTY-SEVEN ELEMENTS.

*Compiled in April, 1901, from the most Recent Data.*

BY THEODORE WILLIAM RICHARDS.

| Name. | Symbol. | Atomic Weight. | Name. | Symbol. | Atomic Weight. |
|---|---|---|---|---|---|
| Aluminium | Al | 27.1 | Molybdenum | Mo | 96.0 |
| Antimony | Sb | 120.0 | Neodymium | Nd | 143.6 |
| Argon | A | 39.92 | Neon | Ne | 19.94 |
| Arsenic | As | 75.0 | Nickel | Ni | 58.70 |
| Barium | Ba | 137.43 | Niobium | Nb = Cb | 94. |
| Beryllium | Be = Gl | 9.1 | Nitrogen | N | 14.04 |
| Bismuth | Bi | 208. | Osmium | Os | 190.8 |
| Boron | B | 11.0 | Oxygen (standard) | O | 16.000 |
| Bromine | Br | 79.955 | Palladium | Pd | 106.5 |
| Cadmium | Cd | 112.3 | Phosphorus | P | 31.0 |
| Cæsium | Cs | 132.9 | Platinum | Pt | 195.2 |
| Calcium | Ca | 40.1 | Potassium | K | 39.14 |
| Carbon | C | 12.001 | Praseodymium | Pr | 140.5 |
| Cerium | Ce | 140. | Rhodium | Rh | 103.0 |
| Chlorine | Cl | 35.455 | Rubidium | Rb | 85.44 |
| Chromium | Cr | 52.14 | Ruthenium | Ru | 101.7 |
| Cobalt | Co | 59.00 | Samarium ? | Sm | 150. |
| Columbium | Cb = Nb | 94. | Scandium | Sc | 44. |
| Copper | Cu | 63.604 | Selenium | Se | 79.2 |
| "Didymium" | Nd + Pr | 142± | Silicon | Si | 28.4 |
| Erbium | Er | 166. | Silver | Ag | 107.93 |
| Fluorine | F | 19.05 | Sodium | Na | 23.05 |
| Gadolinium | Gd | 156. ? | Strontium | Sr | 87.68 |
| Gallium | Ga | 70.0 | Sulphur | S | 32.065 |
| Germanium | Ge | 72.5 | Tantalum | Ta | 183. |
| Glucinum | Gl = Be | 9.1 | Tellurium | Te | 127.5 ? |
| Gold | Au | 197.3 | Terbium ? | Tb | 160. |
| Helium | He | 3.96 | Thallium | Tl | 204.15 |
| Hydrogen | H | 1.0075 | Thorium | Th | 233. |
| Indium | In | 114. | Thulium ? | Tu | 171. ? |
| Iodine | I | 126.85 | Tin | Sn | 119.0 |
| Iridium | Ir | 193.0 | Titanium | Ti | 48.17 |
| Iron | Fe | 55.9 | Tungsten | W | 184. |
| Krypton | Kr | 81.7 | Uranium | U | 238.5 |
| Lanthanum | La | 138.5 | Vanadium | V | 51.4 |
| Lead | Pb | 206.92 | Xenon | X | 128. |
| Lithium | Li | 7.03 | Ytterbium | Yb | 173. |
| Magnesium | Mg | 24.36 | Yttrium | Yt | 89.0 |
| Manganese | Mn | 55.02 | Zinc | Zn | 65.40 |
| Mercury | Hg | 200.0 | Zirconium | Zr | 90.6 |

## NOTE CONCERNING THE TABLE OF ATOMIC WEIGHTS.

THREE new elements are included in the table, namely, Neon, Krypton, and Xenon, discovered by Ramsay in the atmosphere. Their molecular weights cannot be considered as wholly settled, but approximate values are given in the list. There is a possibility that each of these values, as well as those given for Argon and Helium, should be halved in order to obtain the atomic weights; but for the present it seems safest to assume a monatomic molecule in each case.

Radium, the singular substance discovered by Madame Curié, is not included on account of the great uncertainty concerning its atomic weight. It is possible that some of the work upon thorium and uranium is vitiated by radium, and that the presence of this impurity may account for the inconsistencies of the data. The value given for uranium depends primarily on recent work by Richards and Merigold, as yet unpublished; but the matter cannot be considered as settled.

Attention is called to the low atomic weight of iron,* which was included without comment last year. Investigation upon this important constant is still in progress.

* Richards and Baxter, These Proceedings, **35**, 253. (1900.)

# AMERICAN ACADEMY OF ARTS AND SCIENCES.

REPORT OF THE COUNCIL. — PRESENTED MAY 8, 1901.

## BIOGRAPHICAL NOTICES.


CHARLES CARROLL EVERETT . . . . . EPHRAIM EMERTON.
NATHANIEL HOLMES . . . . . JEREMIAH SMITH.
SILAS WHITCOMB HOLMAN . . . . . CHARLES R. CROSS.
SYLVESTER R. KOEHLER . . . . . CHARLES G. LORING.
JOHN ELBRIDGE HUDSON . . . . . JAMES B. THAYER.
JOHN HARRISON BLAKE . . . . . CLARENCE JOHN BLAKE.
CHARLES FRANKLIN DUNBAR . . . . FRANK WILLIAM TAUSSIG.

# REPORT OF THE COUNCIL.

The Academy has lost twenty-one members by death since the annual meeting of May 9, 1900, as follows: Six Resident Fellows, — Thomas Gaffield, C. C. Everett, N. Holmes, J. E. Hudson, A. Lowell, and S. R. Koehler; Seven Associate Fellows, — J. E. Keeler, H. A. Rowland, G. M. Dawson, J. M. DaCosta, A. Stillé, Wm. Mitchell, and E. E. Salisbury; Seven Foreign Honorary Members, — C. Hermite, J. G. Agardh, W. Kühne, Baron Russell of Killowen, H. Sidgwick, M. Müller, Duc de Broglie, and the Bishop of Oxford.

## CHARLES CARROLL EVERETT.

Charles Carroll Everett, D.D., LL.D., Bussey Professor of Theology and Dean of the Faculty of Divinity in Harvard University, died at Cambridge, October 16, 1900, in the seventy-second year of his age. Dr. Everett was, through his ancestry on both sides, identified with the community in and about Boston. His father's family had long been settled in Dorchester, and that of his mother in Beverly. His father, a graduate of Harvard College in 1806, removed to Brunswick, Maine, soon after his marriage, and entered there upon the practice of the law, which he carried on with distinction throughout his life. Dr. Everett was graduated from Bowdoin College in 1850, and seems to have been drawn first to the study of medicine. He was entered during four years as a student of the Bowdoin Medical College, and studied also with a neighboring practitioner, as was the custom of the time. His literary tastes, however, as well as his somewhat delicate health, led him in the years 1851 and 1852 to spend some time in Europe, chiefly in the study of modern languages and literature, and on his return, while still registered in the Medical School, he was appointed to be Instructor in Modern Languages at Bowdoin. All accounts agree that his service in this

capacity was admirable and duly appreciated, but Bowdoin was at the time going through a financial crisis, which caused its governing board to be more than ordinarily anxious as to a strict interpretation of their trusts. A large endowment had recently been secured upon distinct declarations that Bowdoin was "of the Orthodox Congregational denomination." Dr. Everett had been brought up in the orthodox faith of his mother, but his father was already known as an avowed Unitarian, and his own views were inclining more and more in that direction. On this ground his appointment as Professor, twice made by the Trustees, was rejected by the Overseers, and thus his bent towards theological study definitely determined. He entered the Harvard Divinity School, was graduated there in 1859, and at once entered upon his first and only pastorate at Bangor, Maine. Ten years later, in 1869, he was called to be a professor at Cambridge, and in 1878 was made Dean of the Faculty of Divinity. On the 14th of February, 1871, he was elected a Fellow of the American Academy.

These are the brief outlines of a life singularly filled with varied activities, yet passed within the narrow limits of a remote parish and an academic position. As a pastor, Dr. Everett left upon his parishioners an equal impression as preacher and as man. His first passion was scholarship, but his was a scholarship that did not cut off its votary from human sympathy. His preaching, cast always in philosophic form, was yet in a high degree "practical." It addressed itself to the highest instincts, and sought to direct these by a principle of reason. In the trying times of the Civil War his voice gave no uncertain sound, and he was sought by his fellow-citizens as their orator on many an occasion of civic discussion or commemoration.

The removal to Cambridge gave to Dr. Everett full scope for the literary and speculative tastes which had been developing in Bangor. The "Science of Thought," first published in 1869, was his introduction to the world of technical scholarship. It was a fresh and individual attempt to present, on the lines of the new Hegelian thought, the fundamental processes of the human reason. It attracted wide attention, and became for many their first inspiration to clear and rational thinking. At Cambridge, Dr. Everett's activity was largely absorbed in his regular duties of teaching and administration. His instruction took naturally the form suggested by the nature of his mind. Never, probably, was there any teaching of theology less conventional or, in the narrow sense, less "academic" than his. Theology was to him not a system fixed in forms that could be handed on from master to pupil; it was the inter-

pretation, on broad philosophic principles, of that which Christianity has to contribute to the solution of the universal religious problem. Christianity could be accepted only as it commended itself to the fundamental needs of the human soul. First, then, it must be shown what these needs are, and this Dr. Everett undertook to do in his introductory lectures on the Psychological Basis of Religious Faith. Upon this basis he then developed his presentation of Christian ideas as rationally corresponding to a universal and fundamental demand. These lectures were his real life-work. They furnished the intellectual nucleus about which he gathered the results of his ever ripening thought and his ever wider reading. It is they that have given him his peculiar hold upon a full generation of students, and it is they that will form, if their substance can be restored from the scattered material available, the most complete record of his intellectual life.

Dr. Everett was not a voluminous writer. His best work was done in response to some outward occasion which roused him to formulate his thought upon some given problem. Probably the book most likely to be remembered outside of strictly academic circles is the volume of essays on Poetry, Comedy, and Duty, published in 1891, in which his profound reflection, his wide learning, and his playful fancy found equal scope. His "Gospel of Paul," in 1893, was an altogether original treatment of the Pauline theology, and was, perhaps, the work of his later years which appealed most strongly to himself. His contributions to the "New World," of which he was one of the responsible editors, were numerous and important.

In losing him the University and the world of scholarship have lost a unique figure, an interpreter of truth in a transition age, a guide to all those who were seeking light in the confusion of faiths and in the temptations of doubt. His value as a scholar is to be measured only by his singular quality as a man. After all it was his personality that impressed, and charmed, and made the way clear for the truth he had to convey. He satisfied the inquirer, not by the cheap method of compromise, but by a subtle gift of leading men away from the unessentials to the realities of faith. His mind had that element of greatness which consists in the ability to see through the mists of the unimportant and the transient down to the permanent and the essential in the religious life, and not only to see this but to make it clear to others. One of his greatest aids in exposition was his ever-present sense of humor. If, as he has taught us, the essence of the comic is to be found in the sense of incongruity, it should follow that the truly humorous mind is keen also

to discern the congruities of things. In the midst of the most serious development of an idea, it was often a flash of wit that lit up the obscure point so that it remained clear forever. Quite in harmony with his wide human interest was also his love of outward Nature, and the use he made of it in his writing. All experience contributed with him to the interpretation of that religious instinct which in turn gave to experience its meaning and its purpose.

EPHRAIM EMERTON.

## NATHANIEL HOLMES.

NATHANIEL HOLMES was born at Peterborough, N. H., July 2, 1814. His paternal grandfather was an emigrant from Antrim County, Ireland; afterwards a soldier in the Revolution and a Deacon in the Presbyterian Church. His mother was a daughter of a Presbyterian clergyman, Rev. David Annan, a native of Fifeshire, Scotland. As a boy he worked in a machine shop and on his father's farm. From 1831 to 1833 he was a student in Phillips-Exeter Academy; and he graduated at Harvard in 1837. After spending a year in Maryland as a private tutor, he studied law at the Harvard Law School and in the office of Henry H. Fuller, Esq., in Boston. In 1839 he began practice at St. Louis, Mo. In 1865 he was appointed one of the Judges of the Supreme Court of Missouri, serving until 1868. His judicial opinions are contained in Volumes 36 to 42 (inclusive) of the Missouri Reports. In 1868 he gave up his position on the bench to accept the Royall Professorship of Law in the Harvard Law School. In 1872 he resigned the professorship and returned to the practice of law in St. Louis, where he remained eleven years. In 1883 he returned to Cambridge, and made his home there until his death, on February 26, 1901.

Outside the legal profession, Judge Holmes is best known by his book entitled "The Authorship of Shakespeare," a work designed to prove that the plays attributed to Shakespeare were written by Bacon. This book was first published in 1866, and went through three editions. One of the ablest opponents of the view taken by Judge Holmes has recently said of the latter's book: "This contains the fullest and strongest presentation of the argument in favor of Bacon's authorship which has yet appeared, and it is also marked for its fairness and candor." (Notes on the Bacon-Shakespeare Question, by Hon. Charles Allen, pp. 1 and 2.)

Judge Holmes also published, after his return to Cambridge, a work

in two volumes, "Realistic Idealism in Philosophy Itself," and another work entitled "Philosophy of the Universe." In 1889 he delivered the address at the 150th anniversary of the settlement of Peterborough.

The life of Judge Holmes in Cambridge for the last eighteen years was a very retired one, but it was neither solitary nor unhappy. He was a bachelor, but always had some relatives in his household, and never failed to find adequate companionship in his books. A great reader on a great variety of subjects, with a tenacious memory, he was full of knowledge of all sorts, and was a very interesting talker. Judge Holmes was a man of great candor and of remarkable equanimity. He had had successes and disappointments, but he was neither unduly elated by the one nor depressed by the other.

Judge Holmes was elected Fellow of the Academy May 24, 1870. Having removed from the State, he was elected Associate Fellow May 30, 1876. Having returned to Cambridge, his name was restored to the list of Resident Fellows November 30, 1889.

JEREMIAH SMITH.

## SILAS WHITCOMB HOLMAN.

SILAS WHITCOMB HOLMAN was born at Harvard, Massachusetts, January 20, 1856, and graduated from the Massachusetts Institute of Technology in 1876, having made a specialty of the study of physics throughout his course. He was thereupon appointed to a position as assistant in the physical laboratory of that institution, but on account of illness did not enter upon his duties until a year later. Continuing in the service of the Institute, he was promoted to more advanced positions, and was made Professor of Physics in 1893. Even at this date his health, never firm, had become much impaired, and a few years later it became necessary for him to relinquish active work. In 1897 he was made Emeritus Professor of Physics. He died April 1, 1900.

Professor Holman was elected to membership in this Academy March 14, 1883. His original contributions to science were of high merit, and give evidence both of great skill in manipulation and of remarkably clear insight into the choice of methods for conducting a difficult investigation.

The most important of his researches are those upon the viscosity of air and carbonic acid as affected by temperature, which were published in the Proceedings of this Academy in 1876 and 1885; the first of which was based upon his graduating thesis at the Institute of Technology. These contain by far the most complete study of this difficult subject which

had been made up to their date, and the results are still of standard value. Indeed within the past few years they have played an important part in the advancement of the kinetic theory of gases.

In the Proceedings for 1888 is found a further noteworthy paper written in conjunction with one of his pupils, upon the determination of fixed reference points for thermometric measurements at high temperatures, in which several such points are established.

A number of years later, in 1895, appeared another group of papers, the last published by him, relating to the thermo-electric measurement of high temperatures, and a single paper upon calorimetry, which subjects had occupied much of his attention for some time previously. Of these, the one entitled "Thermo-electric Interpolation Formulæ" is particularly valuable for its critique of the various methods of interpolation which have been employed in dealing with the results of high temperature observations, and that upon the "Melting Points of Aluminium, Silver, Gold, Copper, and Platinum," published in collaboration with his pupils, Lawrence and Barr, contains what are undoubtedly the best measurements of the points of fusion of these metals that had been obtained at the time of their publication. A third paper contains a description of a novel method of calibrating the Le Chatelier thermo-electric pyrometer, and the fourth a new method of applying the cooling correction in measurements of the heat of combustion.

The papers of Professor Holman thus far referred to have all been published in the Proceedings of this Academy. Several others of minor importance have appeared in different scientific journals. An extended critique upon thermometry of precision presented at the Boston meeting of the American Association of the Advancement of Science in 1880 unfortunately was never printed.

Besides his published researches, Professor Holman was the author of several valuable scientific works. The two volumes of "Physical Laboratory Notes," prepared for the use of his pupils in the Massachusetts Institute of Technology, embody the results of many years of successful experience in teaching and form an important contribution to the literature of that subject. They contain much original matter and exhibit a rare discrimination in the selection and comparison of the methods of measurement which are discussed. This is particularly the case with the volume relating to electrical measurement and testing.

In 1892 he published a treatise upon "The Discussion of the Precision of Measurements," the basis of which consisted of the notes of lectures given to his classes. This volume, which is quite unique in its contents,

contains in convenient form a very compendious and lucid consideration of the application of the principles of least squares to the theory of observations, the calculation of their precision and the choice of proportions in designing physical apparatus to be used for measurement. Its value as a text-book has been very great.

The collection of four and five place logarithmic tables prepared in 1896 embodies several features of marked originality, and is prefaced by a brief but exceedingly useful discussion of the fundamental principles of computation which contains many useful suggestions for the economizing of labor.

The last work written by Professor Holman, entitled "Matter, Energy, Force, and Work," appeared in 1898, and is of a character widely different from any of those which preceded it. It is a philosophical study of the fundamental concepts of modern physics in which the subject is approached from the point of view that matter and energy rather than matter and force are the primary entities with which physics has to deal, and that matter itself may be dependent upon energy for its own existence. While not technical in its character, and intended especially for the help of teachers not wholly familiar with modern views, it is distinguished throughout by great clearness, and is a remarkable presentation of the newer modes of viewing the subjects which it considers.

Valuable as are his scientific publications, however, Professor Holman's great work was that of a teacher of young men in the laboratory. From the beginning of his service as an assistant in the Rogers Laboratory of Physics, his influence was marked, and by his patient labors, extending through years, he brought the work which was under his charge to a high state of development. He possessed great skill in the planning of apparatus and methods, and rare judgment as to the processes best suited either for purposes of instruction or for the securing of accurate scientific results. To the development of the Laboratory of Electrical Measurements in the Massachusetts Institute of Technology, he gave for years his best endeavors, and to him is due the success of its work. He was also placed in charge of the newly-instituted Laboratory of Heat Measurements, and though prevented by failing health from developing this as he would have chosen, he laid a solid foundation for those coming after him.

Professor Holman was born a teacher, and never grew weary in his profession. His personal relations with his pupils were very intimate. By that example which is better than the wisest precept, he impressed upon them the pre-eminent necessity of thoroughness, accuracy, and

honesty in all work which they might be called upon to perform either as students or in professional life. He is remembered by them with the most affectionate regard.

Reference has already been made to the interference of ill-health with the prosecution of the labors of Professor Holman. In fact, after reaching manhood he was never in good health, and during almost the whole of his active life as a teacher he struggled with a painful chronic disease, which gradually, though with some intermissions, sapped his strength. His cheerful disposition and persistence in carrying on his work were such that none but those who knew him well were aware of the fact that it was only his indomitable courage which prevented him from yielding to his malady for some years before it finally overcame him. In the spring of 1890 he was obliged to discontinue work for a time. He spent the following year abroad, and came home much improved in health, but the relief was only temporary. In 1895 he finally gave up his work of instruction. For some years after this, however, though confined to his chair, and at last even deprived of sight, he continued to labor diligently, and published the tables of logarithms and the work on Matter and Energy mentioned above. His mind was clear to the last, and his cheerfulness never forsook him. His latest years were his best ones, and his whole life was a fine illustration of the manner in which a noble spirit may rise superior to circumstances and produce the best results under conditions to which an ordinary mind would utterly succumb.

CHAS. R. CROSS.

## SYLVESTER R. KOEHLER.

SYLVESTER R. KOEHLER was born in Leipsic in 1837. He came to America at the age of twelve years. Son of an artist, grandson of a musician, he was destined by inheritance to an artistic career. Its bent was determined by his moving to Boston in 1868 and entering the establishment of L. Prang & Co. as technical manager. This position, after ten years, was given up, that he might devote himself exclusively to his art studies. With Charles C. Perkins and William C. Prime as associate editors, he launched the "Art Review," the most dignificd and scholarly periodical devoted to art that has been published in the United States. It was aimed, to quote the preface, "to dwell upon the larger, more robust, more serious features of modern art," but it was in advance of its time, — the circle to which it appealed was small, and when after

two years its publication ceased, its projector modestly claimed that it had "quickened somewhat the forces at work in the healthy development of art in the United States."

Contributions without number flowed from his pen to magazines and journals in America, to the "Zeitschrift für bildende Kunst" and other periodicals in Germany, and to a few of the London publications.

For a while he held the appointment of Curator of the Section of Graphic Arts in the United States National Museum at Washington.

When, in 1888, the Trustees of the Museum of Fine Arts, Boston, found themselves under the necessity of appointing a Curator of the Department of Prints, Koehler was the expert to whom they turned without hesitation. His appointment to this curatorship gave him the position for which his previous career had fitted him. To the years passed in the Prang establishment he owed a mastery of every detail of the technical processes used in the Graphic Arts. This technical knowledge was supplemented by an artistic temperament, which showed itself also in his fondness for music, in his love of verse, and his skill, though a moderate one, with the pencil. Years of study, too, had given him an intimate acquaintance with the history of his art, and confirmed his judgment. He was an admirable critic of work, both creative and technical. These were rare qualifications for the post offered. In it he not only became the ultimate authority in the land of his adoption, but his knowledge and judgment were held in great esteem in the art centres of Europe.

A man of strong individuality, of critical mind, interested in all problems of life and religion, a bold thinker on questions of social reform, a sharp critic of public abuses, bitterly conscious of the injustices of the world as compared with the ideal life he pictured in verse, he was a radical in his views of bettering human institutions. Yet he was a sympathetic friend, sociable, of quaint humor, and in the conduct of his department distinguished for unfailing, unwearied courtesy to all seekers for information.

At the Museum his career was one of ceaseless activity. Numerous exhibitions were held, the catalogues of which offered the opportunity to impart his knowledge in the introductions and in the copious notes, descriptive, explanatory, and critical, of the etched work of Rembrandt, of Albert Dürer, of Blake, Méryon, Seymour-Haden, the Cheneys, and on various other occasions. Notable among these was that for an exhibition in 1892, "Illustrating the Technical Methods of the Reproductive Arts from the XV. Century," "with special reference to the photo-

mechanical processes," for which there was a steady demand from museums and collectors in Europe long after the edition was exhausted.

His most important work, "Etching," a sumptuous volume with thirty plates by old and modern etchers, and numerous reproductions, was published in New York in 1885, before his appointment at the Museum.

In 1893 he delivered a course of nine lectures before the Lowell Institute, subsequently repeated in Washington, on "Old and Modern Methods of Engraving." At other times he lectured before the Art Club, the Society of Arts, and on various occasions to private classes.

In 1892 Harvard conferred the honorary degree of A. M. He was elected Resident Fellow of the Academy May 10, 1893.

The recent transfer to Harvard of the collections deposited with the Museum, and the sudden acquisition by purchase and bequest of great numbers of prints a year or two before his death, was a source of anxiety to him in his feeble health. The end came suddenly, unexpectedly, but painlessly, following within a year that of his wife. For his reputation one can but regret that his untimely death prevented the completion of a "History of the Art of Color-printing," for which he had accumulated a large amount of material, — a difficult task, for which no one was so well fitted as he to sift the facts and refute prevalent errors.

The large and valuable library which he had accumulated he gave, with many prints, to the Museum of Fine Arts. A list of his publications is given in the twenty-fifth annual report of that Museum.

CHAS. G. LORING.

## JOHN ELBRIDGE HUDSON.

THE duty has been assigned to me of communicating to the Academy some account of our late associate, John Elbridge Hudson, who was elected a Fellow on June 15, 1892, and was a member of the Council from May 8, 1896, to May 10, 1899.

It is a grateful duty, for I had known Mr. Hudson long and well, and had for him a very great regard. He was a student at Harvard College when I first saw him, — a shy, studious, thoughtful boy, at the head of his class. A few years later he walked into the office of the law firm with which I was connected and asked to be received as a student. From that time to the moment of his death — for half of my life and more than half of his — I saw much of him. With few men could he have talked more confidentially of what most concerned him than he did with me, and certainly with few men did I hold a more intimate friendship.

At the time of his death, — on the first day of October last, suddenly, at the railroad station in Beverly, five minutes before he was to take his train for his daily tasks in Boston, — he was a little over sixty-one years of age, having been born in Lynn August 3, 1839. He was a man of a very handsome and impressive presence, tall, large, with a massive head, and an expression in his face of quiet dignity, strength, and composure which truly reported the quality of the inward man, and attracted a respect and confidence that were never disappointed.

Hudson's ancestry runs back to the very early days of the Massachusetts Colony. At his own birthplace of Lynn, the earliest immigrant of his family had settled, — Thomas Hudson, — about 1630. It is said that the first iron works in the country were established on his land, at the head of navigation, below the ford, on the Saugus River. Nine years ago our associate presented to his native city an iron kettle, the first casting made at these works, just two hundred and fifty years before.

His father was John Hudson, of Lynn, and his mother Elizabeth Chase Hall Hilliard, of Cornish, New Hampshire. Through her Mr. Hudson was descended from two clergymen, her great-grandfather and her grandfather, — one the Rev. Dr. David Hall, a graduate of Harvard in 1724, and for sixty years minister of the First Church in Sutton, Massachusetts, and the other the Rev. Samuel Hilliard, "a pioneer in Universalism, and a soldier of the Revolution, serving at Bunker Hill and Bennington." * Mr. Hudson himself was brought up as a Unitarian, and although not a regular attendant upon any church, was a member of the Unitarian Club of Boston.

Educated at the public schools of Lynn, Hudson provided himself with whatever other special fitting for college was needed. He entered Harvard in 1858, being a little older than the average of his class; took distinguished rank as a scholar and graduated in 1862 at the head of his class; became at once a tutor in Harvard College, where for three years he taught Greek, Latin, and Ancient History; and for two years of the same period was a member of the Harvard Law School, where he graduated in 1865.

His work as a tutor gave great satisfaction, and he would have been welcomed as a permanent member of the teaching force at the College. But, with a sound instinct as to the character and reach of his own powers, he chose the world of affairs. As a scholar and a teacher he would, un-

* Memoir by George V. Leverett; The New-England Historical and Genealogical Register, LV. 136.

doubtedly, have been distinguished, but he had a very great and unusual capacity for business, for shaping large affairs and for influencing men, a faculty that would have largely missed its opportunity in the quiet life of a college officer.

He entered the office of Messrs. Chandler, Shattuck and Thayer, as a student, in Boston, in 1865 or 1866. Admitted to the Suffolk Bar in October, 1866, he soon became managing clerk in the office of the firm just mentioned on terms which indicated a high appreciation of his ability; and in February, 1870, on the retirement from the firm of Mr. George O. Shattuck, he became its junior member. Here he continued, during some changes in the firm, until its dissolution in 1878. In the interval between this and the year 1880, when that connection with the telephone business began which was to last for the remaining twenty years of his life, he practised law alone, and added some editorial work upon the tenth volume of the United States Digest. That was a task which it was quite possible to carry through in a seemingly respectable and yet entirely perfunctory fashion. But Mr. Hudson took it up as he took up everything, and planned a volume of distinguished merit. On entering the service of the telephone company he had to leave the completion of the book to another; but he had begun by making a new analysis and classification of the titles of the law employed in the Digest, — one which was so much valued that it forms to-day the model of a recent great undertaking by a Western publishing house, known as the Century Digest, now in general use among lawyers.

Mr. Hudson was thus an active member of the bar for fourteen years. His preference was for office work; very seldom could he be induced to try a case, or to argue a point of law before a court. During the nine years that we were connected with the same firm, before I went to the Law School, in 1874, I can speak of his work from an intimate knowledge of it. He had the oversight of our accounts, and took charge of a great part of the office work, such as the drawing of contracts and wills, and the preparation of pleadings and court papers. In all this, his work was admirably well done. The character of it, at a little later period, attracted the attention of the Chief Justice of the Supreme Court, who sent for him and expressed a wish that he would take the place of Clerk of that court. I recall also the great satisfaction expressed by a client, a very able business man in the China trade, who had had occasion to consult him about some tangled affairs. "I have not seen," he said, "such a head for complicated accounts since my early experience with John M. Forbes."

As I have said, there was another department of work in which it was practically impossible to interest Hudson, that is to say, work in court. You could hardly drive him to take hold of that. He took no pleasure in it and showed little capacity for it. He was always a shy person, little inclined to put himself forward, and absolutely unwilling to appear in public, if he could avoid it; and for that reason the breadth and versatility of his extraordinary powers were sometimes overlooked. Indeed many of those who knew him well and best appreciated his remarkable qualities were surprised at the developments of later years.

Early in 1880, Colonel William H. Forbes, the President of what was soon to become the American Bell Telephone Company, who had known Mr. Hudson in college and also as a lawyer, invited him to become the Solicitor of the Company. The invitation was accepted, and Hudson entered at once upon his new duties. Five years later he was asked to become the General Manager. To accept such a place as that was a serious step. So far he had not left the law, but this new proposition would plunge him into a career of business, and business of a very engrossing sort. He came to talk it over with me; and I had many misgivings. He knew, the Company knew, all his friends knew, what he could do in the law. But this was a new venture. What if all this tremendous, novel, swiftly developing business should not suit him, or should prove too much for him? Was he sure that he could handle it?

I was greatly impressed by his answer. Oh, yes, indeed; as to that he had no doubt whatever; he could handle it well enough. As Solicitor he had got a good insight into the nature of it all, and he had no fears on that head. This confidence in his own powers of dealing with the men and the affairs of so great a concern, a confidence fully justified by the event, opened my eyes to a new side of Hudson's capacity. He took the office, without relinquishing the place of Solicitor, filled it to the entire approval of the Company, added to it the next year that of Vice-President, and in 1887 that of President of the American Telephone and Telegraph Company, then known as The Long Distance Company, and two years later became President also of the main organization, the American Bell Telephone Company. These last two offices he held with great success and distinction up to the time of his death; for the final steps in the absorption of the last named company in the first were not then, and I believe are not yet, completed.

Of the ability which Mr. Hudson showed in guiding and shaping the development of this new and complex industry of the telephone, others

who were associated with him have already spoken. Mr. Francis Blake, one of the directors of the Telephone Company, has said that while Mr. Hudson was Manager and President the number of miles of telephone increased more than tenfold, to over a million miles in 1899, and the number of exchange connections more than sixfold, reaching nearly seventeen hundred millions in the same year; and he adds: "Moreover, during this period there was conceived and developed a system of long-distance service which brought more than half the population of the United States within the limits of telephonic speech. These statistics," he adds, "emphasize the broad statement that the growth of Mr. Hudson's business capacity not only kept pace with, but kept in advance of the ever increasing needs of the companies under his control." *

Added to great intellectual capacity, to a remarkable strength, grasp, and tenacity of mind, Mr. Hudson had another source of power, — his sound moral quality. He made no parade of his integrity, but he was thoroughly honest and honorable, and all who dealt with him saw it. In one of the Company's great law-suits an antagonist thought fit to charge it with indirection in a particular matter. The counsel of the Company, the late William G. Russell, met the charge with a statement by Mr. Hudson. "And I need not say to the court," he added, "that on a question of fact within his knowledge, the word of John E. Hudson imports absolute verity." To a specific reliance upon these personal qualities of the President of the Telephone Company, upon his great intellectual gifts, his forecasting and shaping power, his sound judgment, cautious and yet bold in advancing to meet the great emergencies which he foresaw, upon his absolute integrity and his power over men, in a word, to personal confidence in him, may be traced the investment of millions of dollars in that great corporation.

Undoubtedly Mr. Hudson sacrificed his life to the enormous and ever-growing requirements of the office which he held. It was his habit to rest by going abroad for a month or two in the summer, and to pass the remainder of that season at the seashore within easy reach of his office. It is said, and probably with truth, that he lacked somewhat in one of the qualities of a great administrator, namely, in the power to turn over work to subordinates. He could not bear to see work imperfectly done, when he himself could do it so thoroughly well. His friends had long urged him to withdraw from these heavy cares, and a few years ago he had

* Memoir by Francis Blake; Proceedings of the American Antiquarian Society, October 24, 1900.

well-nigh done it. But he was persuaded to remain, arranging at that time to withdraw in the year 1900. Doubtless, like all strong men, he enjoyed the exercise of his strength. Moreover, the development of the business and increasing complications seemed to demand his personal attention just a little longer, — and so the end came as it did. He seemed, for the most part, to bear it all easily enough, but the strain was immense, incessant, increasing; and before he knew, it was too late.

A word or two more should be said as to Mr. Hudson's mental habits, and his methods of working; and a word or two also as to the personal qualities that made him much beloved.

At home Mr Hudson used to have by the side of his plate, as he sat at table, a pencil and paper, for he knew the worth of a memorandum taken at the moment. In his business he was in the habit of causing to be taken and preserved such memoranda of all that took place at each stage of any particular affair. This full record, perfectly arranged and indexed, was of the utmost service to him in handling his great business. He had only to turn to his books to find a record of everything. Often, indeed, he had no need to turn to his books, unless to convince his interlocutor; for he had an extraordinary capacity of remembering facts, of *visualizing* them, and holding them all mapped and co-ordinated in his mind.

In his private studies he was apt to begin by preparing a chart of the subject, with names and dates and the order and place of leading facts and events, all set forth with extraordinary neatness, open to inspection, and speaking volumes to a glance of the eye. These things, thus quickly visible, passed over into his mind and stood there fixed permanently in a rational order. It was so with places. London and Paris and all their streets *he saw*. He had explored the maps so that he hardly needed them longer. His mind held the maps.

This faculty gave an extraordinary interest to his conversation. Last summer I passed several days with him at his house, and he, later, a week with me at mine. He had been reading Plutarch, and everything about him that he could lay hands on. He was trying to place him and his thought in their true relation to the men and the ideas of the time just past and just to come. He had been reading also of Alexander, and reading with equal ease in the Greek and Latin authors as in those in our own tongue. It was a pleasure of the highest sort to listen to his talk. The precision and extent of his knowledge, the way in which it lay in his mind, co-ordinated with whatever related things threw light

upon it, these and the breadth and illuminating good sense of his own reflections were equally instructive and delightful. Alexander and Plutarch stood out before you in their true place in history, and in their true relations to the men, the dates, and the events of their time.

No one could see Hudson without guessing at the strength and force of his character; and no one who knew him well could fail to see that under his gentle demeanor there lay qualities of energy and passion that were not to be trifled with when once they were aroused. But he was an affectionate and charming friend, and one that women and little children and those who were dependent upon him loved.

Mr. Hudson married in 1871 Miss Eunice Wells Healey, of Hampton Falls, New Hampshire, who survives him, to bear a most heavy loss. He left no children. One sister also survives him, the wife of Samuel J. Hollis of Lynn.

He went little into society and but little to the larger clubs.* He was happiest at home, and there he gave himself up to the refined and simple pleasures in which he always had his chief enjoyment. He had a large library, of great range and variety, to which he was forever adding. Most of all he seemed to like, at the end of the day, to sit down among his books and explore his old friends the Greek and Roman classics, — reading them, as he did, with entire ease in the original. When it came to the matter of his real tastes and likings, as his associate Mr. Leverett has happily said, "He was, above all, a scholar, fond of his home."

JAMES B. THAYER.

---

* Mr. Hudson was a member of many societies and clubs. In the Memoir for the Historic Genealogical Society, already quoted, Mr. Leverett says: "Mr. Hudson was at the time of his death a vice-president of this Society. He was also a fellow of the American Academy of Arts and Sciences, a member of the Corporation of the Massachusetts Institute of Technology, a member of the American Antiquarian Society, the American Association for the Advancement of Science, the British Association for the Advancement of Science, American Geographical Society, National Geographic Society, the Colonial Society of Massachusetts, the American Institute of Electrical Engineers, the Virginia Historical Society, the Association for the Preservation of Virginia Antiquities, the Bostonian Society, Selden Society, Hakluyt Society, Lynn Historical Society, the Bar Association of the City of Boston, and also of the Algonquin, Boston Art, Exchange, National Arts, St. Botolph, Union, University, and other social clubs." It may be added that he took much pleasure in one or two social clubs made up of college friends or contemporaries.

## JOHN HARRISON BLAKE.

In reviewing the printed matter, letters, completed manuscripts, and note-books which furnish the material for a personal memoir of my father, I have been impressed by the paucity of record of the achievements of an active life extending over the greater part of a century.

The reason for this is to be found in the character of the life itself, looking rather to accomplishment than to recognition, and seeking to express the sense of an obligation for the privilege of living by doing the work at hand simply and well.

Of published papers there are but few, — the Transactions of this Academy, of which he was elected a member May 30, 1843, contain none, other journals in the library of the Academy but five, and the records of the Boston Society of Civil Engineers, of which he was one of the founders and its first Secretary, an equally small number.

Of letters, especially family letters, there are many, all clearly written, containing information as to his travels and treating of the subjects in the study of which he was most interested.

Of the manuscripts, the majority, in the form of essays, were written after his retirement from active life with the evident purpose of continuing a companionship which has, to his son, the value both of a precious memory and a continued inspiration; the persistency with which this purpose was pursued, under conditions of failing strength and sight, is shown especially in one of them, begun in ink, continued in black and then in blue pencil when the blue mark alone was visible to him, and concluded by sense of touch.

These essays cover a wide range of scientific subjects and bear witness to an intellectual activity persisting to within the last three years of a life which ended, as gently and as graciously as it had been lived, at the age of ninety years. Through this life there had run one dominant purpose, — that of usefulness; in it there had always been one keen pleasure, — that of scientific research. The note-books, containing many valuable records and memoranda, are the transcripts of a variously active professional life, — one series covers very nearly the whole of the early experimental and constructive history of the manufacture of illuminating gas in this country, another is a record of researches in the chemistry of arts and manufacture, and another is devoted to mining, metallurgy, and civil engineering.

John H. Blake, the youngest son of Thomas and Mary Lowell Barnard Blake, was born December 5, 1808, in the house still standing on

Washington Street, corner of Union Park Street; he died in his home on Marlborough Street, Boston, July 5, 1899, in his ninety-first year. Mr. Blake was educated in private schools and in the English High School, which he entered in 1821 as a member of its first class. Later he became a pupil of the Rev. James Blake Howe, then rector of the West Parish Church in Claremont, N. H., whose daughter, a second cousin, he married on his return from his explorations in South America.

While his studies with Mr. Howe were mainly classical and he was fitted to enter Harvard, his interest in chemistry and in anatomy was such as to lead him to prefer these studies to those of a collegiate course principally literary and mathematical. It was in pursuit of his chosen subjects that, after a period of study in a chemical manufacturing establishment, he became assistant to, and pupil of, Dr. Webster, from whom he received valuable instruction, which enabled him in the year 1827, when only nineteen years of age, to establish, with money advanced by his father, the Norfolk Laboratory, for the manufacture of pure drugs and chemicals. This laboratory was situated in Jamaica Plain near Forest Hills, upon the Dedham Turnpike. One of its products was pure sulphuric ether, and it was in the larger laboratory of later construction that the ether used in the first demonstration of the value of ether anaesthesia was made under Mr. Blake's personal supervision. In addition to the commercial work of the laboratory Mr. Blake carried on a series of investigations into the physiological effects of poisons, the composition of precious stones, and the production of alloys applicable to the mechanic arts. At the end of three years of successful operation the buildings were destroyed by a fire, resulting from the explosion of a carboy of ether, but were immediately rebuilt on a larger scale; a joint stock company was formed, arrangements were made with the Rothschilds for the importation of quicksilver, and with a house in Tuscany controlling what was then the world's principal supply of boric acid; and Mr. Maximilian Isnard, who introduced the manufacture of beet-root sugar into France, became an associate.

At that time but little was known of the sources of supply of nitrate of soda, of which large quantities were used in the works, beyond the names of the small ports on the coast of Peru from which it was shipped.

Ignorance on the subject, the value of the article, and the novelty of entering and exploring an unknown region were sufficient incentives to turn Mr. Blake's thoughts in this direction rather than along the beaten lines of travel in search of the rest and recreation which he needed after eight years of anxious labor. Books gave very little information concern-

ing the country between the Pacific Ocean and the Andes, constituting the extreme southern part of Peru, the western part of Bolivia, and the northern part of Chili, and all the knowledge that could be obtained was that it was, for the most part, uninhabited and uninhabitable, destitute of vegetation, and known as the Desert of Atacama; it was on the shores of the northern part of this desert that the shipment ports referred to were situated.

The winter of 1835 and 1836 was very cold, New York harbor was frozen over, and it was not until the 10th of February, 1836, nearly a month after the time proposed for her departure, that the ship "Factor," in which Mr. Blake was a passenger, made her way through a channel cut in the ice and sailed for Valparaiso, where she arrived June 9, sailing again on the 9th of July for Arica and Tacna, whence Mr. Blake proceeded by land to Pisaqua and Iquique, arriving at the latter place on the 6th of August. The next three months were devoted to surveys in the province of Tarapaca, and on the 7th of November Mr. Blake left Iquique with a pack train, two Indians, and dogs to make the first recorded exploration of the Desert of Atacama from north to south, arriving at Valparaiso on the 10th of March, having occupied four months and three days in a trying passage over an arid and waterless region, in which all of the animals were lost and the men nearly perished from thirst.

On March 15 Mr. Blake left Valparaiso for Buenos Ayres by Santiago, the pass of Uspalato and Mendoza, crossing the Andes and the Pampas de la Plata, arriving on the 28th of April and making preparations for immediate departure for the United States.*

At this time Rosas, the then Dictator of the Argentine Republic, was engaged in strengthening his position by military activity and the projected subjection of the Indian tribes to the westward. Mr. Blake was detained as consulting engineer on fortifications, and was not released until the autumn of 1837,† when he returned to the United States to find

* The only record of this interesting and perilous journey is to be found in family letters, in the collection of mummies and other objects of archæological value now in the Peabody Museum, Cambridge, and in the description of this collection published from Mr. Blake's notes in the reports of the Museum. The carefully kept notebook, containing not only the daily incidents of travel, but especially the memoranda of geologic observations, of barometric measurements and surveys, was stolen after Mr. Blake's return to this country, and never recovered.

† Information to be derived from a traveller who had just crossed the continent was of value, and Mr. Blake received a courteous note, saying that a house adjoining that of the British Embassy had been placed at his disposal, and requesting him

a condition of general financial disaster, in which the Norfolk Laboratory had shared and which made it impossible to take up the grants for the mining and exportation of nitre secured from the Peruvian government. Under these conditions he accepted the management of the Fernandez copper mines in Santa Clara, Cuba, married, and took up his residence there, where, in addition to the work in hand, he made observations on the character and climate of the country. In 1847 he assisted in the geologic survey of Isle Royale, Lake Superior,* and in 1848 entered into partnership with Franklin Darracott as a civil engineer, to which work he added that of a consulting chemist and geologist. It was his custom to make no charge for consultation to individuals seeking to develop new industries, regarding this as his contribution to the general welfare. Among many to whom he gave valuable advice were Goodyear and Babbitt.

The business of the firm of Blake and Darracott had largely to do with gas engineering and the construction of gas works, and Mr. Blake organized and was at one time president of five gas companies, his executive ability and power of control over men making such work a pleasure. In addition he was interested in iron and gold mining, carrying on the ore beds and blast furnaces and car wheel works at Brandon, Vermont, and organizing and operating the Yahoola River Hydraulic Mining Company, of which he was president, in the Dahlonega belt, Georgia. After the dissolution of the firm of Blake and Darracott he became interested in street railways, building the Middlesex Road and being the President of the Metropolitan Road during the period of the Civil War: subsequently he was President of the Connecticut Arms Manufacturing Company, and organized and was the first President of the Chapman Valve Manufacturing Company.

One of Mr. Blake's latest contributions to manufactures was the so-called antique glass. Wishing to carry out previous experiments on molecular movement in solids at protracted high temperatures, he constructed a crucible furnace in South Boston, and in order to make it pay its expenses manufactured glass upon the basis of his earlier analyses of precious stones, the result being a glass of great brilliancy and vivid color.

---

to remain as the guest of the Dictator. The invitation was declined, but was repeated in an equally courteous note brought by a file of soldiers, the note further stating that the Dictator trusted that the invitation would be accepted, as it would pain him to be obliged to provide any narrower accommodation.

* The promontory at the northeasterly extremity of the island is called Blake Point.

The mental activity which had stimulated bodily action beyond the usual term of working years continued to find its expression, even after he had become confined to the limits of his own home, in the manuscripts which contain those products of his mental laboratory impossible of record in busier times; as might be expected they give an insight into the motive power of his life and show the strength of a character which looked forward calmly to bodily dissolution as a part of the process of growth to greater knowledge.

Through the vicissitudes of incessant and protracted work, with the usual meed of disappointment and much of physical pain, Mr. Blake held always the cheerful courage born of a simple faith, which counted life as a primary school and the suffering of his advanced years as a part of its graduating exercises; prominent in my memory of him are his fearlessness, his kindliness, his love of truth, and his earnest desire not to fail in doing his part of the world's work, whatever that might honestly be, and this also, that in fifty-seven years of a dear and close companionship, I cannot recall a single unkind, unjust, or impatient word.

CLARENCE JOHN BLAKE.

## CHARLES FRANKLIN DUNBAR.

CHARLES FRANKLIN DUNBAR, Fellow of the American Academy for twenty-eight * years, Professor of Political Economy in Harvard University for nearly thirty years, was born at Abington, Massachusetts, July 28, 1830, and died at Cambridge, Mass., January 29, 1900.

Professor Dunbar's career divides itself into two very different parts; a first, during which he was editor and guiding spirit of the Boston Daily Advertiser; and a second, during which he lived the quiet life of the teacher and scholar.

It was not until he had reached mature manhood that he entered on his newspaper career. After graduating from Harvard College in 1851, he engaged for a short time in business; then, health failing, spent a year in farming; then studied at the Harvard Law School and in the office of the late Justice E. R. Hoar, and was admitted to the Bar in 1858. Meanwhile, contributions from his pen had appeared in the Advertiser; and finally, in 1859, he became permanently associated with

* Elected January 31, 1872.

that newspaper. At first associate editor, he became in 1864 sole responsible editor, and such he remained until he severed his connection with the Advertiser.

The decade during which he was thus in charge of the most influential newspaper in New England was the most trying and perhaps the most important in the country's history. His position as editor brought him into contact with leading men in every sort of career in New England. Both his conduct of the paper, and his association with men, gradually gave him a position of respect and confidence in the community, rarely obtained by those in charge of ephemeral publications. He wrote constantly on a great variety of subjects; on political and military affairs as a matter of course, but with special care and with unusual judgment on the remarkable financial and economic events of the period. His editorials were marked from the outset by the grace and dignity of style which characterized everything that came from his pen. They showed, moreover, the firm and unwavering spirit of the man; never abating by a jot the conviction that in spite of defeat and disaster, in spite of foreign complications and domestic disaffection, the war must be carried on unflinchingly until the supremacy of the Union should be restored. There is not only steadfast faith, but often inspiring eloquence, in the editorial pages of the Advertiser as Professor Dunbar conducted them; and not seldom, after a military failure, his courageous words rang through the community like a bugle blast.

The financial and economic events of this period were of the most extraordinary and varied kind. A huge national debt, a new banking system, an immense and complicated system of taxation, a high protective tariff, an excessive issue of paper money, a wearisome struggle between the advocates of paper money and specie, the turmoil of reconstruction in the South, — such were the phenomena to which the editor of the Advertiser was compelled to give daily attention. His inborn aptitude led him to observe the course of events with keen sagacity, and gave him a fund of experience invaluable for his later career. Few economists have been so fortunate in having been brought into unremitting contact with the actual affairs of life. Few also have been so fortunate in securing contact with men of all classes and all opinions. Daily there came into the office of the editor of the Advertiser persons of every sort, bringing advice, exhortation, information. A characteristic trait of Professor Dunbar's showed itself in these conferences, — a remarkable capacity for silent attention. However certain of his own

ground, he would listen without response to those whose views were different from his own, refrain from stating his objections unless the situation imperatively called for statement, and give his auditor an impression, and a true impression, of respectful and sympathetic interest; and yet in due time would follow the course which his own judgment dictated as wise. The quality of his mind was eminently judicial. He saw all sides of a difficult question so clearly that he sympathized with those who saw perhaps only one side. In the Advertiser office he dealt with business men, statesmen, soldiers, conservatives, radicals, visionaries; learned something from all, dealt courteously with all, gained the respect of all, and yet never failed to maintain his own sound and independent judgment.

The most active and strenuous years of Professor Dunbar's life, between the ages of twenty-nine and thirty-nine, were given to the Advertiser. In his hands its editorship was distinctly a public service; and, cool-headed and sagacious as he was, uninfluenced by any vapid sentimentalism, he so regarded his vocation. But his strength, never very great, was seriously shaken by these ten years of severe application, and in 1869, when the Advertiser changed hands, Professor Dunbar was glad to dispose of his interest and to retire from the paper.

Shortly after, he was offered a professorship of political economy in Harvard University. This was a career he had never looked forward to, and he doubted his own capacity for it. Nevertheless, after some hesitation, he accepted, on condition that he should have time for restoring his strength and adding to his equipment. After two years spent in Europe in study and travel, he entered in 1871 on the duties of the professorship, to which he devoted himself for the rest of his life.

Although thus launched on the career of a scholar and teacher, his abilities were such as to cause him to be enlisted soon in the work of guiding and managing the affairs of the University. On the retirement of the late Professor Gurney, in 1876, he became Dean of the Faculty of Harvard College, and retained that post until 1882. When the present Faculty of Arts and Sciences in Harvard University was organized in 1890, he became its first Dean, and so acted until 1895. In addition, he served frequently on committees, and was in constant intercourse with the President of the University, who relied greatly on his advice. Repeatedly through his academic career, he was called upon to act as judge, as mediator and pacificator, as organizer of new plans, as administrator of new systems. All these duties were discharged with remarkable judgment and success; yet they were felt by him to be

distractions from his chief task as professor in a great institution of learning.

Professor Dunbar's career as editor, and his administrative work in Harvard University, need to be borne in mind when making an estimate of his work as scholar and man of science. To those who knew him well, nothing was more admirable in his career than the solidity of his scholarly attainments, the breadth of his interests, the maturity of his conclusions on his chosen subjects. It might have been expected that one who had been a busy newspaper editor, and who remained to the end keenly interested in current political happenings, should continue to deal largely with questions of the day, and take an active part in current discussion of public issues. Professor Dunbar, however, had too clear a perception of the ideals and duties of a scholar to give himself to newspaper and periodical writing. For many years he delved in the literature of political economy at large, and equipped himself in the whole range of his subject. Not only the writings of contemporary economists, but those of earlier days, especially the English and French authors of the seventeenth and eighteenth centuries, and those of Ricardo's school, were thoroughly examined. It is characteristic of Professor Dunbar that notwithstanding the wide scope of his reading in the theoretic literature of political economy, he published virtually nothing on this phase of the subject; though the maturity of the conclusions derived from that reading are unmistakably evident in some of his essays on the recent phases of economic theory. He regarded these researches as essential to his equipment as a University teacher, partly also as preparation for the inquiries by which he hoped eventually to contribute to the world's stock of knowledge and thought.

The special subjects on which he planned to publish the results of research, and to which he gave most attention in the later years of his life, were public finance, taxation, currency, banking. It was to these that he had given most attention among the economic topics that presented themselves to him as editor of the Advertiser; it was to these that his own bent most attracted him. His range of information on them was remarkably wide. Here, again, his writings give but fragmentary indication of the extent of his attainments. He was familiar with the financial history and fiscal experiences of England and France quite as much as with those of the United States, to which his writings were chiefly devoted. And not only was he familiar with the facts; he was singularly skilful in interpreting them. All who had the pleasure of following his courses of instruction in the University

found before them the conclusions of a sagacious mind, furnished with ample information on every essential aspect of the situation. It was Professor Dunbar's undeviating habit to turn to the primary sources of information, — to the statutes, the official documents, the contemporary sources of knowledge. He was never content with information at second hand, and was frequently able to point out how the conclusions of authors of repute were overthrown by a careful comparison with the sources from which their conclusions should have been derived.

Professor Dunbar's writings, as already intimated, were comparatively scanty; they were certainly scanty as compared with what he was equipped to do. His little book on Banking, brief and unpretentious, is a model, and indeed well-nigh a classic, in its field. His essays on the financial history of the United States, published in the Quarterly Journal of Economies, are also models of their kind. Occasional comparisons, undertaken in these essays, with the financial experience of other countries, — as, for example, in the essay on Some Precedents followed by Alexander Hamilton, — give indication of the wide range of his researches. Similar evidence appears in essays on some recondite and little understood phases of economic history, such as those on the Bank of Amsterdam, on the Bank of Venice, and on Early Banking Schemes. Those who had the privilege of Professor Dunbar's intimate acquaintance knew that he had pushed his way into other obscure and difficult places also. He had given much attention to the history of the Assignats in France, and to the peculiarities in the course of depreciation during that remarkable episode in monetary history. On this subject he had collected, as was his habit, a store of contemporary material, and had planned at some time to present the results of his researches in published form. He had undertaken a minute and careful study of the financial administration of Alexander Hamilton, of which the results appeared in print only to a very slight extent. He had followed with equal thoroughness the history of banking operations in the United States, especially from the middle of the century to the present time; but here also failing strength and an untimely death prevented the execution of his matured plans.

No small part of Professor Dunbar's time and thought was given in the later years of his life to the Quarterly Journal of Economics. That Journal was established by Harvard University in 1886, Professor Dunbar being appointed its editor, and remaining in charge from 1886 to 1896. It was a very different editorial post from that which he had held on the Advertiser; but its duties were performed with no less

fidelity and skill. From the first a high standard was set. The Journal was to be a medium of communication for investigators, and took rank at once as one of the leading scholarly repertories on its subject. Space in it was sought by eminent writers the world over, and publication in its pages served as guarantee of a claim to the attention of the learned world. Professor Dunbar always looked back with just satisfaction on what he had here achieved, and found in it some solace for his inability to carry out his plans for independent publication.

Professor Dunbar was by nature reserved; always dignified; in conversation, happy in the intuitive selection of the right word; guarded in expressing an opinion, but sure to express a just one when his conclusions had been reached. His writings reflected these qualities. They are distinguished by a rounded stateliness of diction more sought for a generation ago than in our own day; dignified, yet never stilted, flowing, yet never affected. No more just and delightful tribute has been paid to a man in his own lifetime than is contained in Professor Dunbar's paper on President Eliot's Administration of Harvard University, published in the Harvard Graduates' Magazine (for June, 1894) at the close of the twenty-fifth year of President Eliot's administration. Equally sympathetic, and at the same time judicial and discriminating, are his memoirs, in the Proceedings of this Academy, of three men of very different types, — Henry C. Carey, Francis A. Walker, and E. W. Gurney.

It is a singular fact that Professor Dunbar wrote with hesitation, and often had to nerve himself anew to the task of literary composition. Notwithstanding many years of experience in rapid writing, he shrank from taking pen in hand; yet, when the first sentence was written, the others followed apparently with ease, and certainly in logical sequence and with an immediate happy choice of phrase. The present writer has been so fortunate as to examine some of the notes, memoranda, and unfinished manuscript left by his lamented colleague; and in the briefest and most fragmentary of these papers he has been repeatedly struck by the appositeness of the language, the instinctively systematic arrangement, the constant proof of clear and well ordered thought.

In personal intercourse with those who enjoyed his more intimate acquaintance, Professor Dunbar's habitual dignity and reserve were often broken by flashes of humor. He enjoyed keenly a good story, and saw the mirthful side of every subject. Often in solemn meetings the twinkle of his eye, perceptible only to those who knew him well, showed his appreciation of the oddities and idiosyncrasies of his contemporaries.

As is common with men whose sense of humor is strong, his affection was deep and lasting; and in the domestic circle the devotion which he gave and received was touching. His character, not less than his abilities and attainments, won from associates in varied walks of life an universal feeling of esteem and admiration.

F. W. TAUSSIG.

There have been no resignations during the year, but one Resident Fellow has abandoned his fellowship. One Resident Fellow, having removed from Massachusetts, has been elected to Associate Fellowship.

New members elected during the year are: Resident Fellows, 7; Associate Fellows, 9; Foreign Honorary Members, 9.

The roll of the Academy now includes 197 Resident Fellows, 96 Associate Fellows, and 70 Foreign Honorary Members.*

* By election, May 8, 1901, the roll is 198, 98, 74.

# American Academy of Arts and Sciences.

## OFFICERS AND COMMITTEES FOR 1900-1901.

### PRESIDENT.

ALEXANDER AGASSIZ.

### VICE-PRESIDENT.

| Class I. | Class II. | Class III. |
|---|---|---|
| JOHN TROWBRIDGE. | ALPHEUS HYATT. | JAMES B. THAYER. |

### CORRESPONDING SECRETARY.

WILLIAM M. DAVIS.

### RECORDING SECRETARY.

WILLIAM WATSON.

### TREASURER.

FRANCIS BLAKE.

### LIBRARIAN.

A. LAWRENCE ROTCH.

### COUNCILLORS.

| Class I. | Class II. | Class III. |
|---|---|---|
| HENRY TABER, | WILLIAM T. COUNCILMAN, | JAMES B. AMES, |
| THEODORE W. RICHARDS, | JOHN E. WOLFF, | WILLIAM EVERETT, |
| HARRY M. GOODWIN. | GEORGE H. PARKER. | A. LAWRENCE LOWELL. |

### COMMITTEE OF FINANCE.

ALEXANDER AGASSIZ, FRANCIS BLAKE, ELIOT C. CLARKE.

### RUMFORD COMMITTEE.

ERASMUS D. LEAVITT, EDWARD C. PICKERING, CHARLES R. CROSS,
AMOS E. DOLBEAR, ARTHUR G. WEBSTER, THEODORE W. RICHARDS,
THOMAS C. MENDENHALL.

### C. M. WARREN COMMITTEE.

CHARLES L. JACKSON, SAMUEL CABOT, HENRY B. HILL,
LEONARD P. KINNICUTT, ARTHUR M. COMEY, ROBERT H. RICHARDS,
HENRY P. TALBOT.

### COMMITTEE OF PUBLICATION.

SAMUEL H. SCUDDER, SETH C. CHANDLER, CRAWFORD H. TOY.

### COMMITTEE ON THE LIBRARY.

A. LAWRENCE ROTCH, HENRY W. HAYNES, SAMUEL HENSHAW.

### AUDITING COMMITTEE.

HENRY G. DENNY, WILLIAM L. RICHARDSON.

# LIST

OF THE

# FELLOWS AND FOREIGN HONORARY MEMBERS.

(Corrected to May 20, 1901.)

---

## RESIDENT FELLOWS. — 198.

(Number limited to two hundred.)

### Class I. — *Mathematical and Physical Sciences.* — 80.

#### Section I. — 21.

*Mathematics and Astronomy.*

| | |
|---|---|
| Solon I. Bailey, | Cambridge. |
| Maxime Bôcher, | Cambridge. |
| William E. Byerly, | Cambridge. |
| Seth C. Chandler, | Cambridge. |
| A. W. Duff, | Worcester. |
| Gustavus Hay, | Boston. |
| Theodore Lyman, | Brookline. |
| Henry Mitchell, | Nantucket. |
| William F. Osgood, | Cambridge. |
| James Mills Peirce, | Cambridge. |
| Edward C. Pickering, | Cambridge. |
| William H. Pickering, | Cambridge. |
| John Ritchie, Jr., | Boston. |
| John D. Runkle, | Cambridge. |
| T. H. Safford, | Williamstown. |
| Edwin F. Sawyer, | Brighton. |
| Arthur Searle, | Cambridge. |
| William E. Story, | Worcester. |
| Henry Taber, | Worcester. |
| O. C. Wendell, | Cambridge. |
| P. S. Yendell, | Dorchester. |

#### Section II. — 21.

*Physics.*

| | |
|---|---|
| A. Graham Bell, | Washington, D.C. |
| Clarence J. Blake, | Boston. |
| Francis Blake, | Weston. |
| Charles R. Cross, | Brookline. |
| Amos E. Dolbear, | Somerville. |
| H. M. Goodwin, | Roxbury. |
| Edwin H. Hall, | Cambridge. |
| Hammond V. Hayes, | Cambridge. |
| William L. Hooper, | Somerville. |
| William W. Jacques, | Newton. |
| Frank A. Laws, | Boston. |
| Henry Lefavour, | Williamstown. |
| T. C. Mendenhall, | Worcester. |
| Benjamin O. Peirce, | Cambridge. |
| A. Lawrence Rotch, | Boston. |
| Wallace C. Sabine, | Cambridge. |
| John S. Stone, | Boston. |
| Elihu Thomson, | Swampscott. |
| John Trowbridge, | Cambridge. |
| A. G. Webster, | Worcester. |
| Robert W. Willson, | Cambridge. |

SECTION III. — 22.

*Chemistry.*

| | |
|---|---|
| Samuel Cabot, | Boston. |
| Arthur M. Comey, | Cambridge. |
| James M. Crafts, | Boston. |
| Charles W. Eliot, | Cambridge. |
| Henry B. Hill, | Cambridge. |
| Charles L. Jackson, | Cambridge. |
| Walter L. Jennings, | Worcester. |
| Leonard P. Kinnicutt, | Worcester. |
| Charles F. Mabery, | Cleveland, O. |
| Arthur Michael, | Boston. |
| George D. Moore, | Worcester. |
| Charles E. Munroe, | Wash'gton, D.C. |
| John U. Nef, | Chicago, Ill. |
| Arthur A. Noyes, | Boston. |
| Robert H. Richards, | Boston. |
| Theodore W. Richards, | Cambridge. |
| Charles R. Sanger, | Cambridge. |
| Stephen P. Sharples, | Cambridge. |
| Francis H. Storer, | Boston. |
| Henry P. Talbot, | Newton. |
| Charles H. Wing, | Ledger, N. C. |
| Edward S. Wood, | Boston. |

SECTION IV. — 16.

*Technology and Engineering.*

| | |
|---|---|
| Eliot C. Clarke, | Boston. |
| Ira N. Hollis, | Cambridge. |
| L. M. Johnson, | Cambridge. |
| Gaetano Lanza, | Boston. |
| E. D. Leavitt, | Cambridge. |
| William R. Livermore, | Boston. |
| Hiram F. Mills, | Lowell. |
| Cecil H. Peabody, | Boston. |
| Alfred P. Rockwell, | Manchester. |
| Andrew H. Russell, | Wash'ton, D.C. |
| Peter Schwamb, | Arlington. |
| H. L. Smyth, | Cambridge. |
| Charles S. Storrow, | Boston. |
| George F. Swain, | Boston. |
| William Watson, | Boston. |
| Morrill Wyman, | Cambridge. |

CLASS II. — *Natural and Physiological Sciences.* — 64.

SECTION I. — 13.

*Geology, Mineralogy, and Physics of the Globe.*

| | |
|---|---|
| H. H. Clayton, | Milton. |
| Algernon Coolidge, | Boston. |
| William O. Crosby, | Boston. |
| William M. Davis, | Cambridge. |
| Benj. K. Emerson, | Amherst. |
| O. W. Huntington, | Newport, R. I. |
| Robert T. Jackson, | Cambridge. |
| William H. Niles, | Cambridge. |
| John E. Pillsbury, | Boston. |
| Nathaniel S. Shaler, | Cambridge. |
| Robert DeC. Ward, | Cambridge. |
| John E. Wolff, | Cambridge. |
| J. B. Woodworth, | Cambridge. |

SECTION II. — 12.

*Botany.*

| | |
|---|---|
| F. S. Collins, | Malden. |
| Geo. E. Davenport, | Medford. |
| William G. Farlow, | Cambridge. |
| Charles E. Faxon, | Boston. |
| Merritt L. Fernald, | Cambridge. |
| George L. Goodale, | Cambridge. |
| H. H. Hunnewell, | Wellesley. |
| John G. Jack, | Boston. |
| B. L. Robinson, | Cambridge. |
| Charles S. Sargent, | Brookline. |
| Arthur B. Seymour, | Cambridge. |
| Roland Thaxter, | Cambridge. |

SECTION III. — 24.

*Zoölogy and Physiology.*

| | |
|---|---|
| Alexander Agassiz, | Cambridge. |
| Robert Amory, | Boston. |

| | |
|---|---|
| James M. Barnard, | Milton. |
| Henry P. Bowditch, | Boston. |
| William Brewster, | Cambridge. |
| Louis Cabot, | Brookline. |
| William E. Castle, | Cambridge. |
| Samuel F. Clarke, | Williamstown. |
| W. T. Councilman, | Boston. |
| Charles B. Davenport, | Chicago, Ill. |
| Harold C. Ernst, | Boston. |
| Edward G. Gardiner, | Boston. |
| Samuel Henshaw, | Cambridge. |
| Alpheus Hyatt, | Cambridge. |
| John S. Kingsley, | Somerville. |
| Edward L. Mark, | Cambridge. |
| Charles S. Minot, | Boston. |
| Edward S. Morse, | Salem. |
| George H. Parker, | Cambridge. |
| James J. Putnam, | Boston. |
| Samuel H. Scudder, | Cambridge. |
| William T. Sedgwick, | Boston. |
| James C. White, | Boston. |
| William M. Woodworth, | Cambridge. |

SECTION IV. — 15.

*Medicine and Surgery.*

| | |
|---|---|
| Samuel L. Abbot, | Boston. |
| Edward H. Bradford, | Boston. |
| Arthur T. Cabot, | Boston. |
| David W. Cheever, | Boston. |
| Frank W. Draper, | Boston. |
| Thomas Dwight, | Boston. |
| Reginald H. Fitz, | Boston. |
| Charles F. Folsom, | Boston. |
| Frederick I. Knight, | Boston. |
| Samuel J. Mixter, | Boston. |
| W. L. Richardson, | Boston. |
| Theobald Smith, | Boston. |
| O. F. Wadsworth, | Boston. |
| Henry P. Walcott, | Cambridge. |
| John C. Warren, | Boston. |

## CLASS III. — *Moral and Political Sciences.* — 54.

SECTION I. — 9.

*Philosophy and Jurisprudence.*

| | |
|---|---|
| James B. Ames, | Cambridge. |
| Horace Gray, | Boston. |
| John C. Gray, | Boston. |
| G. Stanley Hall, | Worcester. |
| Geo. F. Hoar, | Worcester. |
| Francis C. Lowell, | Boston. |
| Josiah Royce, | Cambridge. |
| Jeremiah Smith, | Cambridge. |
| James B. Thayer, | Cambridge. |

SECTION II. — 21.

*Philology and Archæology.*

| | |
|---|---|
| William S. Appleton, | Boston. |
| Charles P. Bowditch, | Boston. |
| Lucien Carr, | Cambridge. |
| Franklin Carter, | Williamstown. |
| Joseph T. Clarke, | Boston. |
| Henry G. Denny, | Boston. |
| William Everett, | Quincy. |
| J. W. Fewkes, | Washington. |
| William W. Goodwin, | Cambridge. |
| Henry W. Haynes, | Boston. |
| Charles R. Lanman, | Cambridge. |
| David G. Lyon, | Cambridge. |
| Bennett H. Nash, | Boston. |
| Frederick W. Putnam, | Cambridge. |
| Edward Robinson, | Boston. |
| F. B. Stephenson, | Boston. |
| Joseph H. Thayer, | Cambridge. |
| Crawford H. Toy, | Cambridge. |
| John W. White, | Cambridge. |
| John H. Wright, | Cambridge. |
| Edward J. Young, | Waltham. |

SECTION III. — 12.

*Political Economy and History.*

| | |
|---|---|
| Charles F. Adams, | Lincoln. |
| Edward Atkinson, | Boston. |
| Andrew M. Davis, | Cambridge. |
| Ephraim Emerton, | Cambridge. |
| John Fiske, | Cambridge. |

| | |
|---|---|
| A. C. Goodell, | Salem. |
| Henry C. Lodge, | Nahant. |
| A. Lawrence Lowell, | Boston. |
| James F. Rhodes, | Boston. |
| Denman W. Ross, | Cambridge. |
| Charles C. Smith, | Boston. |
| F. W. Taussig, | Cambridge. |

SECTION IV. — 12.

*Literature and the Fine Arts.*

| | |
|---|---|
| Francis Bartlett, | Boston. |
| John Bartlett, | Cambridge. |
| Arlo Bates, | Boston. |
| George S. Boutwell, | Groton. |
| J. Elliot Cabot, | Brookline. |
| T. W. Higginson, | Cambridge. |
| George L. Kittredge, | Cambridge. |
| Charles G. Loring, | Boston. |
| Percival Lowell, | Boston. |
| Charles Eliot Norton, | Cambridge. |
| Horace E. Scudder, | Cambridge. |
| Barrett Wendell, | Boston. |

## ASSOCIATE FELLOWS. — 98.

(Number limited to one hundred. Elected as vacancies occur.)

### Class I. — *Mathematical and Physical Sciences.* — 37.

#### Section I. — 14.

*Mathematics and Astronomy.*

Edward E. Barnard, Williams Bay, [Wis.
S. W. Burnham, Chicago.
George Davidson, San Francisco.
Fabian Franklin, Baltimore.
Asaph Hall, Cambridge, Mass.
George W. Hill, W. Nyack, N.Y.
E. S. Holden, Washington.
Emory McClintock, Morristown, N.J.
E. H. Moore, Chicago.
Simon Newcomb, Washington.
Charles L. Poor, Baltimore.
George M. Searle, Washington.
J. N. Stockwell, Cleveland, O.
Chas. A. Young, Princeton, N. J.

#### Section II. — 7.

*Physics.*

Carl Barus, Providence, R.I.
J. Willard Gibbs, New Haven.
G. E. Hale, Williams Bay.
S. P. Langley, Washington.
A. A. Michelson, Chicago.
Ogden N. Rood, New York.
E. L. Nichols, Ithaca.

#### Section III. — 8.

*Chemistry.*

T. M. Drown, So. Bethlehem, Pa.
Wolcott Gibbs, Newport, R.I.
Frank A. Gooch, New Haven.
S. W. Johnson, New Haven.
J. W. Mallet, Charlottesville, Va.
E. W. Morley, Cleveland, O.
J. M. Ordway, New Orleans.
Ira Remsen, Baltimore.

#### Section IV. — 8.

*Technology and Engineering.*

Henry L. Abbot, New York.
Cyrus B. Comstock, New York. [Va.
W. P. Craighill, Charlestown, W.
John Fritz, Bethlehem, Pa.
F. R. Hutton, New York.
George S. Morison, Chicago.
William Sellers, Edgemoor, Del.
Robt. S. Woodward, New York.

### Class II. — *Natural and Physiological Sciences.* — 34.

#### Section I. — 14.

*Geology, Mineralogy, and Physics of the Globe.*

Cleveland Abbe, Washington.
George J. Brush, New Haven.
T. C. Chamberlin, Chicago.
Edward S. Dana, New Haven.
Walter G. Davis, Cordova, Arg.
G. K. Gilbert, Washington.
Clarence King, New York.
Joseph LeConte, Berkeley, Cal.
J. Peter Lesley, Milton, Mass.
S. L. Penfield, New Haven.
J. W. Powell, Washington.
R. Pumpelly, Newport, R.I.
A. R. C. Selwyn, Vancouver.
Charles D. Walcott, Washington.

SECTION II. — 6.

*Botany.*

| | |
|---|---|
| L. H. Bailey, | Ithaca. |
| D. H. Campbell, | Palo Alto, Cal. |
| J. M. Coulter, | Chicago. |
| C. G. Pringle, | Charlotte, Vt. |
| John D. Smith, | Baltimore. |
| W. Trelease, | St. Louis. |

SECTION III. — 8.

*Zoölogy and Physiology.*

| | |
|---|---|
| Joel A. Allen, | New York. |
| W. K. Brooks, | Lake Roland, Md. |
| F. P. Mall, | Baltimore. |
| S. Weir Mitchell, | Philadelphia. |
| H. F. Osborn, | New York. |
| A. S. Packard, | Providence, R.I. |
| A. E. Verrill, | New Haven. |
| C. O. Whitman, | Chicago. |

SECTION IV. — 6.

*Medicine and Surgery.*

| | |
|---|---|
| John S. Billings, | New York. |
| W. S. Halsted, | Baltimore. |
| W. W. Keen, | Philadelphia. |
| William Osler, | Baltimore. |
| Wm. H. Welch, | Baltimore. |
| H. C. Wood, | Philadelphia. |

## CLASS III. — *Moral and Political Sciences.* — 27.

SECTION I. — 6.

*Philosophy and Jurisprudence.*

| | |
|---|---|
| James C. Carter, | New York. |
| Joseph H. Choate, | New York. |
| Melville W. Fuller, | Washington. |
| William W. Howe, | New Orleans. |
| Charles S. Peirce, | Milford, Pa. |
| T. R. Pynchon, | Hartford, Conn. |

SECTION II. — 7.

*Philology and Archæology.*

| | |
|---|---|
| Timothy Dwight, | New Haven. |
| B. L. Gildersleeve, | Baltimore. |
| D. C. Gilman, | Baltimore. |
| T. R. Lounsbury, | New Haven. |
| Rufus B. Richardson, | Athens. |
| Thomas D. Seymour, | New Haven. |
| A. D. White, | Ithaca, N.Y. |

SECTION III. — 6.

*Political Economy and History.*

| | |
|---|---|
| Henry Adams, | Washington. |
| G. P. Fisher, | New Haven. |
| H. E. von Holst, | Chicago. |
| Henry C. Lea, | Philadelphia. |
| Henry M. Stevens, | Ithaca. |
| W. G. Sumner, | New Haven. |

SECTION IV. — 8.

*Literature and the Fine Arts.*

| | |
|---|---|
| James B. Angell, | Ann Arbor, Mich. |
| L. P. di Cesnola, | New York. |
| H. H. Furness, | Wallingford, Pa. |
| R. S. Greenough, | Florence. |
| Augustus St. Gaudens, | New York. |
| John S. Sargent, | London. |
| E. C. Stedman, | Bronxville, N. |
| W. R. Ware, | New York. |

## FOREIGN HONORARY MEMBERS. — 74.

(Number limited to seventy-five. Elected as vacancies occur.)

### Class I. — *Mathematical and Physical Sciences.* — 24.

#### Section I. — 7.

*Mathematics and Astronomy.*

| | |
|---|---|
| Arthur Auwers, | Berlin. |
| George H. Darwin, | Cambridge. |
| H. A. E. A. Faye, | Paris. |
| Sir William Huggins, | London. |
| H. Poincaré, | Paris. |
| Otto Struve, | Karlsruhe. |
| H. C. Vogel, | Potsdam. |

#### Section II. — 6.

*Physics.*

| | |
|---|---|
| Ludwig Boltzmann, | Vienna. |
| A. Cornu, | Paris. |
| Oliver Heaviside, | Newton Abbot. |
| F. Kohlrausch, | Berlin. |
| Lord Rayleigh, | Witham. |
| Sir G. G. Stokes, Bart., | Cambridge. |

#### Section III. — 6.

*Chemistry.*

| | |
|---|---|
| Adolf Baeyer, | Munich. |
| Marcellin Berthelot, | Paris. |
| J. H. van't Hoff, | Berlin. |
| D. Mendeleeff, | St. Petersburg. |
| Sir H. E. Roscoe, | London. |
| Julius Thomsen, | Copenhagen. |

#### Section IV. — 5.

*Technology and Engineering.*

| | |
|---|---|
| Sir Benjamin Baker, | London. |
| Lord Kelvin, | Largs. |
| Maurice Lévy, | Paris. |
| H. Müller-Breslau, | Berlin. |
| William C. Unwin, | London. |

### Class II. — *Natural and Physiological Sciences.* — 27.

#### Section I. — 7.

*Geology, Mineralogy, and Physics of the Globe.*

| | |
|---|---|
| Sir Archibald Geikie, | London. |
| Albert Heim, | Zurich. |
| Sir John Murray, | Edinburgh. |
| A. E. Nordenskiöld, | Stockholm. |
| Freih. v. Richthofen, | Berlin. |
| Henry C. Sorby, | Sheffield. |
| Heinrich Wild, | Zurich. |

#### Section II. — 6.

*Botany.*

| | |
|---|---|
| E. Bornet, | Paris. |
| A. Engler, | Berlin. |
| Sir Joseph D. Hooker, | Sunningdale. |
| W. Pfeffer, | Leipsic. |
| H. Graf zu Solms-Laubach, | Strassburg. |
| Eduard Strasburger, | Bonn. |

SECTION III.—8.

*Zoölogy and Physiology.*

| | |
|---|---|
| Sir Michael Foster, | Cambridge. |
| Carl Gegenbauer, | Heidelberg. |
| Ludimar Hermann, | Königsberg. |
| A. von Kölliker, | Würzburg. |
| A. Kovalevsky, | St. Petersburg. |
| H. Kronecker, | Bern. |
| H. de Lacaze-Duthiers, | Paris. |
| Elias Metschnikoff, | Paris. |

SECTION IV.—6.

*Medicine and Surgery.*

| | |
|---|---|
| Sir T. L. Brunton, | London. |
| A. Celli, | Rome. |
| R. Koch, | Berlin. |
| Lord Lister, | London. |
| F. v. Recklinghausen, | Strassburg. |
| Rudolph Virchow, | Berlin. |

CLASS III.—*Moral and Political Sciences.*—23.

SECTION I.—5.

*Philosophy and Jurisprudence.*

| | |
|---|---|
| Heinrich Brunner, | Berlin. |
| A. V. Dicey, | Oxford. |
| W. E. Hearn, | Melbourne. |
| F. W. Maitland, | Cambridge. |
| Sir Frederick Pollock, Bart., | London. |

SECTION III.—4

*Political Economy and History.*

| | |
|---|---|
| James Bryce, | London. |
| Herman Grimm, | Berlin. |
| Theodor Mommsen, | Berlin. |
| Sir G. O. Trevelyan, Bart., | London. |

SECTION II.—7.

*Philology and Archæology.*

| | |
|---|---|
| Ingram Bywater, | Oxford. |
| W. Dörpfeld, | Athens. |
| Sir John Evans, | Hemel Hempstead. |
| H. Jackson, | Cambridge. |
| J. W. A. Kirchhoff, | Berlin. |
| G. C. C. Maspero, | Paris. |
| Karl Weinhold, | Berlin. |

SECTION IV.—7.

*Literature and the Fine Arts.*

| | |
|---|---|
| E. de Amicis, | Florence. |
| Georg Brandes, | Copenhagen. |
| F. Brunetière, | Paris. |
| Jean Léon Gérôme, | Paris. |
| Rudyard Kipling, | Rottingdean. |
| G. Paris, | Paris. |
| Leslie Stephen, | London. |

# STATUTES AND STANDING VOTES.

## STATUTES.

*Adopted May* 30, 1854: *amended September* 8, 1857, *November* 12, 1862, *May* 24, 1864, *November* 9, 1870, *May* 27, 1873, *January* 26, 1876, *June* 16, 1886, *October* 8, 1890, *January* 11 *and May* 10, 1893, *May* 9 *and October* 10, 1894, *March* 13, April 10 *and May* 8, 1895, *and May* 8, 1901.

### CHAPTER I.

#### Of Fellows and Foreign Honorary Members.

1. The Academy consists of Resident Fellows, Associate Fellows and Foreign Honorary Members. They are arranged in three Classes, according to the Arts and Sciences in which they are severally proficient, viz.: Class I. The Mathematical and Physical Sciences; — Class II. The Natural and Physiological Sciences; — Class III. The Moral and Political Sciences. Each Class is divided into four Sections, viz.: Class I., Section 1. Mathematics and Astronomy; — Section 2. Physics; — Section 3. Chemistry; — Section 4. Technology and Engineering. Class II., Section 1. Geology, Mineralogy, and Physics of the Globe; — Section 2. Botany; — Section 3. Zoölogy and Physiology; — Section 4. Medicine and Surgery. Class III., Section 1. Philosophy and Jurisprudence: — Section 2. Philology and Archæology; — Section 3. Political Economy and History; — Section 4. Literature and the Fine Arts.

2. The number of Resident Fellows shall not exceed two hundred. Only residents in the Commonwealth of Massachusetts shall be eligible to election as Resident Fellows, but resident fellowship may be retained after removal from the Commonwealth. Each Resident Fellow shall pay an admission fee of ten dollars and such annual assessment, not exceeding ten dollars, as shall be voted by the Academy at each annual

meeting. Resident Fellows only may vote at the meetings of the Academy.

3. The number of Associate Fellows shall not exceed one hundred, of whom there shall not be more than forty in either of the three classes of the Academy. Associate Fellows shall be chosen from persons residing outside of the Commonwealth of Massachusetts. They shall not be liable to the payment of any fees or annual dues, but on removing within the Commonwealth they may be transferred by the Council to resident fellowship as vacancies there occur.

4. The number of Foreign Honorary Members shall not exceed seventy-five; and they shall be chosen from among persons most eminent in foreign countries for their discoveries and attainments in either of the three departments of knowledge above enumerated. There shall not be more than thirty Foreign Members in either of these departments.

## CHAPTER II.

### Of Officers.

1. There shall be a President, three Vice-Presidents, one for each Class, a Corresponding Secretary, a Recording Secretary, a Treasurer, and a Librarian, which officers shall be annually elected, by ballot, at the Annual Meeting, on the second Wednesday in May.

2. At the Annual Meeting of 1901, nine Councillors shall be elected by ballot, one from each Class of the Academy to serve for one year, one from each Class for two years, and one from each Class for three years; and at annual meetings thereafter three Councillors shall be elected in the same manner, one from each Class, to serve for three years; but the same Fellow shall not be eligible for two successive terms. The nine Councillors, with the President, the three Vice-Presidents, the two Secretaries, the Treasurer, and the Librarian, shall constitute the Council. Five members shall constitute a quorum. It shall be the duty of this Council to exercise a discreet supervision over all nominations and elections. With the consent of the Fellow interested, they shall have power to make transfers between the several Sections of the same Class, reporting their action to the Academy.

3. If any office shall become vacant during the year, the vacancy shall be filled by a new election, and at the next stated meeting, or at a meeting called for this purpose.

## CHAPTER III.

### Of Nominations of Officers.

1. At the stated meeting in March, the President shall appoint from the next retiring Councillors a Nominating Committee of three Fellows, one for each class.

2. It shall be the duty of this Nominating Committee to prepare a list of candidates for the offices of President, Vice-Presidents, Corresponding Secretary, Recording Secretary, Treasurer, Librarian, Councillors, and the Standing Committees which are chosen by ballot; and to cause this list to be sent by mail to all the Resident Fellows of the Academy not later than four weeks before the Annual Meeting.

3. Independent nominations for any office, signed by at least five Resident Fellows and received by the Recording Secretary not less than ten days before the Annual Meeting, shall be inserted in the call for the Annual Meeting, which shall then be issued not later than one week before that meeting.

4. The Recording Secretary shall prepare for use, in voting at the Annual Meeting, a ballot containing the names of all persons nominated for office under the conditions given above.

5. When an office is to be filled at any other time than at the Annual Meeting, the President shall appoint a Nominating Committee in accordance with the provisions of Section 1, which shall announce its nomination in the manner prescribed in Section 2 at least two weeks before the time of election. Independent nominations, signed by at least five Resident Fellows and received by the Recording Secretary not later than one week before the meeting for election, shall be inserted in the call for that meeting.

## CHAPTER IV.

### Of the President.

1. It shall be the duty of the President, and, in his absence, of the senior Vice-President present, or next officer in order as above enumerated, to preside at the meetings of the Academy; to summon extraordinary meetings, upon any urgent occasion; and to execute or see to the execution of the Statutes of the Academy. Length of continuous membership in the Academy shall determine the seniority of the Vice-Presidents.

2. The President, or, in his absence, the next officer as above enumerated, is empowered to draw upon the Treasurer for such sums of money as the Academy shall direct. Bills presented on account of the Library, or the Publications of the Academy, must be previously approved by the respective committees on these departments.

3. The President, or, in his absence, the next officer as above enumerated, shall nominate members to serve on the different committees of the Academy which are not chosen by ballot.

4. Any deed or writing to which the common seal is to be affixed shall be signed and sealed by the President, when thereto authorized by the Academy.

## CHAPTER V.

### Of Standing Committees.

1. At the Annual Meeting there shall be chosen the following Standing Committees, to serve for the year ensuing, viz.: —

2. The Committee of Finance, to consist of the President, Treasurer, and one Fellow chosen by ballot, who shall have charge of the investment and management of the funds and trusts of the Academy. The general appropriations for the expenditures of the Academy shall be moved by this Committee at the Annual Meeting, and all special appropriations from the general and publication funds shall be referred to or proposed by this Committee.

3. The Rumford Committee, of seven Fellows, to be chosen by ballot, who shall consider and report on all applications and claims for the Rumford Premium, also on all appropriations from the income of the Rumford Fund, and generally see to the due and proper execution of this trust.

4. The C. M. Warren Committee, of seven Fellows, to be chosen by ballot, who shall consider and report on all applications for appropriations from the income of the C. M. Warren Fund, and generally see to the due and proper execution of this trust.

5. The Committee of Publication, of three Fellows, one from each Class, to whom all communications submitted to the Academy for publication shall be referred, and to whom the printing of the Memoirs and the Proceedings shall be intrusted.

6. The Committee on the Library, of the Librarian ex officio and three other Fellows, one from each class, who shall examine the Library, and make an annual report on its condition and management.

7. An Auditing Committee of two Fellows, for auditing the accounts of the Treasurer.

## CHAPTER VI.

### Of the Secretaries.

1. The Corresponding Secretary shall conduct the correspondence of the Academy, recording or making an entry of all letters written in its name, and preserving on file all letters which are received; and at each meeting he shall present the letters which have been addressed to the Academy since the last meeting. Under the direction of the Council for Nomination, he shall keep a list of the Resident Fellows, Associate Fellows, and Foreign Honorary Members, arranged in their Classes and in Sections in respect to the special sciences in which they are severally proficient; and he shall act as secretary to the Council.

2. The Recording Secretary shall have charge of the Charter and Statute-book, journals, and all literary papers belonging to the Academy. He shall record the proceedings of the Academy at its meetings; and after each meeting is duly opened, he shall read the record of the preceding meeting. He shall notify the meetings of the Academy, apprise officers and committees of their election or appointment, and inform the Treasurer of appropriations of money voted by the Academy. He shall post up in the Hall a list of the persons nominated for election into the Academy; and when any individual is chosen, he shall insert in the record the names of the Fellows by whom he was nominated.

3. The two Secretaries, with the Chairman of the Committee of Publication, shall have authority to publish such of the records of the meetings of the Academy as may seem to them calculated to promote its interests.

## CHAPTER VII.

### Of the Treasurer.

1. The Treasurer shall give such security for the trust reposed in him as the Academy shall require.

2. He shall receive officially all moneys due or payable, and all bequests or donations made to the Academy, and shall pay such sums as the Academy may direct. He shall keep an account of all receipts and expenditures; shall submit his accounts to the Auditing Committee; and shall report the same at the expiration of his term of office.

3. The Treasurer shall keep separate accounts of the income and appropriation of the Rumford Fund and of other special funds, and report the same annually.

4. All moneys which there shall not be present occasion to expend shall be invested by the Treasurer, under the direction of the Finance Committee.

## CHAPTER VIII.

### Of the Librarian and Library.

1. It shall be the duty of the Librarian to take charge of the books, to keep a correct catalogue of them, to provide for the delivery of books from the Library, and to appoint such agents for these purposes as he may think necessary. He shall make an annual report on the condition of the Library.

2. The Librarian, in conjunction with the Committee on the Library, shall have authority to expend such sums as may be appropriated, either from the General, Rumford or other special Funds of the Academy, for the purchase of books, and for defraying other necessary expenses connected with the Library.

3. To all books in the Library procured from the income of the Rumford Fund, or other special funds, the Librarian shall cause a stamp or label to be affixed, expressing the fact that they were so procured.

4. Every person who takes a book from the Library shall give a receipt for the same to the Librarian or his assistant.

5. Every book shall be returned in good order, regard being had to the necessary wear of the book with good usage. If any book shall be lost or injured, the person to whom it stands charged shall replace it by a new volume or set, if it belongs to a set, or pay the current price of the volume or set to the Librarian; and thereupon the remainder of the set, if the volume belonged to a set, shall be delivered to the person so paying for the same.

6. All books shall be returned to the Library for examination at least one week before the Annual Meeting.

7. The Librarian shall have custody of the Publications of the Academy and shall distribute copies among the Associate Fellows and Foreign Honorary Members, at their request. With the advice and consent of the President, he may effect exchanges with other associations.

## CHAPTER IX.

### Of Meetings.

1. There shall be annually four stated meetings of the Academy; namely, on the second Wednesday in May (the Annual Meeting), on the second Wednesday in October, on the second Wednesday in January, and on the second Wednesday in March. At these meetings only, or at meetings adjourned from these and regularly notified, shall appropriations of money be made, or alterations of the statutes or standing votes of the Academy be effected.

2. Fifteen Fellows shall constitute a quorum for the transaction of business at a stated meeting. Seven Fellows shall be sufficient to constitute a meeting for scientific communications and discussions.

3. The Recording Secretary shall notify the meetings of the Academy to each Fellow residing in Boston and the vicinity; and he may cause the meetings to be advertised, whenever he deems such further notice to be needful.

## CHAPTER X.

### Of the Election of Fellows and Honorary Members.

1. Elections shall be made by ballot, and only at stated meetings.

2. Candidates for election as Resident Fellows must be proposed by two Resident Fellows of the section to which the proposal is made, in a recommendation signed by them, and this recommendation shall be transmitted to the Corresponding Secretary, and by him referred to the Council for nomination. No person recommended shall be reported by the Council as a candidate for election, unless he shall have received a written approval, signed at a meeting of the Council by at least five of its members. All nominations thus approved shall be read to the Academy at a stated meeting, and shall then stand on the nomination list during the interval between two stated meetings, and until the balloting. No person shall be elected a Resident Fellow, unless he shall have been resident in this Commonwealth one year next preceding his election. If any person elected a Resident Fellow shall neglect for one year to pay his admission fee, his election shall be void; and if any Resident Fellow shall neglect to pay his annual assessments

for two years, provided that his attention shall have been called to this article, he shall be deemed to have abandoned his Fellowship; but it shall be in the power of the Treasurer, with the consent of the Council, to dispense (*sub silentio*) with the payment both of the admission fee and of the assessments, whenever in any special instance he shall think it advisable so to do.

3. The nomination of Associate Fellows may take place in the manner prescribed in reference to Resident Fellows. The Council may in like manner originate nominations of Associate Fellows, which must be read at a stated meeting previous to the election, and be exposed on the nomination list during the interval.

4. Foreign Honorary Members shall be chosen only after a nomination made at a meeting of the Council, signed at the time by at least seven of its members, and read at a stated meeting previous to that on which the balloting takes place.

5. Three fourths of the ballots cast must be affirmative, and the number of affirmative ballots must amount to eleven to effect an election of Fellows or Foreign Honorary Members.

6. A majority of any section of the Academy is empowered to present lists of persons deemed best qualified to fill vacancies occurring in the number of Foreign Honorary Members or Associate Fellows allotted to it; and such lists, after being read at a stated meeting, shall be referred to the Council for Nomination.

7. If, in the opinion of a majority of the entire Council, any Fellow — Resident or Associate — shall have rendered himself unworthy of a place in the Academy, the Council shall recommend to the Academy the termination of his Fellowship; and provided that a majority of two thirds of the Fellows at a stated meeting, consisting of not less than fifty Fellows, shall adopt this recommendation, his name shall be stricken off the roll of Fellows.

## CHAPTER XI.

### Of Amendments of the Statutes.

1. All proposed alterations of the Statutes or additions to them, shall be referred to a committee, and, on their report at a subsequent meeting, shall require for enactment a majority of two thirds of the members present, and at least eighteen affirmative votes.

2. Standing votes may be passed, amended, or rescinded, at any

stated meeting, by a majority of two thirds of the members present. They may be suspended by a unanimous vote.

## CHAPTER XII.

### Of Literary Performances.

1. The Academy will not express its judgment on literary or scientific memoirs or performances submitted to it, or included in its publications.

## STANDING VOTES.

1. Communications of which notice had been given to the Secretary shall take precedence of those not so notified.

2. Resident Fellows who have paid all fees and dues chargeable to them are entitled to receive one copy of each volume or article printed by the Academy, on application to the Librarian personally or by written order, within two years from the date of publication. And the current issues of the Proceedings shall be supplied, when ready for publication, free of charge, to all the Fellows and members of the Academy who desire to receive them.

3. The Committee of Publication shall fix from time to time the price at which the publications of the Academy may be sold. But members may be supplied at half this price with volumes which they are not entitled to receive free, and which are needed to complete their sets.

4. Two hundred extra copies of each paper accepted for publication in the Memoirs or Proceedings of the Academy shall be placed at the disposal of the author, free of charge.

5. Resident Fellows may borrow and have out from the Library six volumes at any one time, and may retain the same for three months, and no longer.

6. Upon special application, and for adequate reasons assigned, the Librarian may permit a larger number of volumes, not exceeding twelve, to be drawn from the Library for a limited period.

7. Works published in numbers, when unbound, shall not be taken from the Hall of the Academy, except by special leave of the Librarian.

8. Books, publications, or apparatus shall be procured from the income of the Rumford Fund only on the certificate of the Rumford Committee that they, in their opinion, will best facilitate and encourage the making of discoveries and improvements which may merit the Rumford Premium.

9. The Annual Meeting and the other stated meetings shall be holden at eight o'clock, P. M.

10. A meeting for receiving and discussing scientific communications may be held on the second Wednesday of each month not appointed for stated meetings, excepting July, August, and September.

## RUMFORD PREMIUM.

In conformity with the terms of the gift of Benjamin, Count Rumford, granting a certain fund to the American Academy of Arts and Sciences, and with a decree of the Supreme Judicial Court for carrying into effect the general charitable intent and purpose of Count Rumford, as expressed in his letter of gift, the Academy is empowered to make from the income of said fund, as it now exists, at any Annual Meeting, an award of a gold and a silver medal, being together of the intrinsic value of three hundred dollars, as a premium to the author of any important discovery or useful improvement in light or in heat, which shall have been made and published by printing, or in any way made known to the public, in any part of the continent of America, or any of the American islands; preference being always given to such discoveries as shall, in the opinion of the Academy, tend most to promote the good of mankind; and to add to such medals, as a further premium for such discovery and improvement, if the Academy see fit so to do, a sum of money not exceeding three hundred dollars.

# INDEX.


Ageratum lucidum, 475.
rhytidophyllum, 476.
stachyofolium, 476.
Alcoceria, 493.
Pringlei, 493.
Alternating Current Waves, 319.
Archaeoplax signifera, 7.
Archibald, E. H. *See* Richards, T. W., and Archibald, E. H.
Arctostaphylos Conzattii, 497.
glabrata, 497.
Arthropod Trails, 61.
Arthrorhynchus Cyclopodiae, 407.
Eucampsipodae, 409.
Atomic Weights, 169; Table of, 545.

Barus, C., Award of Rumford Premium to, 520, 529.
Behr, G. E. *See* Jackson, C. L., and Behr, G. E.
Bigelowia Nelsonii, 505.
Biographical Notices, List of, 547.
John Harrison Blake, 565.
Charles Franklin Dunbar, 569.
Charles Carroll Everett, 549.
Silas Whitcomb Holman, 553.
Nathaniel Holmes, 552.
John Eldridge Hudson, 558.
Sylvester R. Koehler, 556.
Bisbee, H. *See* Richards, T. W., McCaffrey, C. F., and Bisbee, H.
Bowers, M. A., Peripheral Distribution of the Cranial Nerves of Spelerpes bilineatus, 177–193.
Brickellia amblyolepis, 485.
cardiophylla, 485.
glomerata, 504.
hebecarpoides, 486.
petrophila, 486.
petrophila, var. umbratilis, 487.
vernicosa, 487.

Calcic Oxalate, 375.
Cancer, Phylogeny of, 1.
Cancer proavitus, 3.
Calea Pringlei, 488.
Zacatechichi, 488.
Calhane, D. F. *See* Jackson, C. L., and Calhane, D. F.
California Petroleum, 255, 283.
Calochortus Pringlei, 472.
Ceraiomyces, 410.
Dahlii, 410.
Chandler, S. C., New Discovery concerning the Motion of the Earth's Pole, 538.
Chemical Laboratory of Case School of Applied Science, Contributions from, 253.
Chemical Laboratory of Harvard College, Contributions from, 73, 143, 195, 229, 331, 339, 375, 507.
Clayton, H. H., The Eclipse Cyclone and the Diurnal Cyclones, 305–318.
Cohoe, W. P. *See* Jackson, C. L., and Cohoe, W. P.
Cologania Deamii, 492.
Committee of Publication, Report of, 527.
Conyza lyrata, var. pilosa, 506.
Cordia Seleriana, 498.
Correspondence, 517, 534, 535, 538, 542.
Council, Report of, 547.
Crab, Fossil, 1.
Cranial Nerves of Spelerpes, 177.
Crew, H., Report of Progress to Rumford Committee, 521.
Croton Palmeri, var. ovalis, 493.
Cryptogamic Laboratory of Harvard University, Contributions from, 395.
Crystals, Study of Growing, 339.
Cyclones, 305.

Davis, W. M., Geographical Notes on Brittany and Devonshire, 535.
Design as a Science, 355.

Diffusivities, Thermal, of Marbles, 11.
Dimeromyces coarctatus, 410.
crispatus, 413.
rhizophorus, 412.
Dioscorea platycolpota, 471.
Diurnal Cyclones, 305.

Earle, R. B. *See* Jackson, C. L., and Earle, R. B.
Eclipse Cyclone, 305.
Electrical Conductivity of Iron, 119.
Eumelampodium, 456.
Eupatorium anisopodum, 477.
araliaefolium, 477.
Bigelovii, 477.
conspicuum, 477.
Coulteri, 477.
dasycarpum, 478.
dryophilum, 478.
Gonzalezii, 479.
hyssopinum, 478.
Lemmoni, 479.
leonense, 479.
Liebmannii, 480.
longifolium, 480.
lucidum, 480.
Luxii, 480.
lyratum, 481.
Mariarum, 481.
pachypodum, 481.
pansamalense, 482.
pinabetense, 482.
pleianthum, 483.
prionobium, 483.
prionophyllum, 484.
quadrangulare, 484.
viscidipes, 484.
Euphorbia calcicola, 496.
interaxillaris, 495.
lancifolia, var. villicaulis, 496.
muscicola, 495.
potosina, 495.
puberula, 494.
Everett, W., The Life and Works of the late Henry Sidgwick, 538.
Evolvulus Seleriana, 498.

Fellows, Associate, deceased, —
Frederick Edwin Church, 517.
Jacob Mandes DaCosta, 534.
George Mercer Dawson, 539.
James Edward Keeler, 534.
William Mitchell, 534.
Henry Augustus Rowland, 549.
Edward Elbridge Salisbury, 542.
Fellows, Associate, deceased, —
Alfred Stillé, 534.
Fellows, Associate, elected, —
George Mercer Dawson, 531.
Thomas Messenger Drown, 535.
Melville Weston Fuller, 532.
Charles Ellery Hale, 540.
William Stewart Halsted, 540.
William Williams Keen, 540.
Franklin Paine Mall, 540.
Eliakim Hastings Moore, 539.
Edward Leamington Nichols, 540.
Henry Fairfield Osborn, 540.
Cyrus Guernsey Pringle, 540.
Rufus Byam Richardson, 532.
Thomas Day Seymour, 532.
Henry Morse Stevens, 532.
Charles Otis Whitman, 540.
Fellows, Associate, List of, 581.
Fellows, Resident, deceased, —
Charles Carroll Everett, 539.
Thomas Gaffield, 537.
Nathaniel Holmes, 549.
John Elbridge Hudson, 534.
Sylvester R. Koehler, 534.
Augustus Lowell, 534.
Fellows, Resident, elected, —
William Ernest Castle, 531.
Frank Shipley Collins, 539.
Alexander Wilmer Duff, 539.
Ephraim Emerton, 539.
Merritt Lyndon Fernald, 531.
Lewis Jerome Johnson, 539.
Theodore Lyman, 539.
Henry Lloyd Smyth, 539.
Frank William Taussig, 539.
Jay Backus Woodworth, 531.
Fellows, Resident, List of, 577.
Fernald, M. L., Some New Spermatophytes from Mexico and Central America, 489–506.
Fimbristylis alamosana, 491.
Holwayana, 492.
melanospora, 491.
obscura, 492.
Foreign Honorary Members, deceased, —
Jacob Georg Azarth, 542.
Duc de Broglie, 549.
Charles Hermite, 538.
Willy Kühne, 534.
Max Müller, 549.
Baron Russell of Killowen, 534.
Henry Sidgwick, 534.
William Stubbs, 549.

Foreign Honorary Members, elected, —
Edmondo de Amicis, 541.
Sir Thomas Lander Brunton, 540.
Albert Venn Dicey, 540.
Sir Archibald Geikie, 532.
William Edward Hearn, 540.
Henry Jackson, 541.
Robert Koch, 540.
Hugo Kronecker, 540.
Heinrich Müller-Breslau, 540.
Sir John Murray, 532.
Jules Henri Poincaré, 540.
William Cawthorn Unwin, 532.
Foreign Honorary Members, List of, 583.
Fossil Crab from Gay Head, 1.
Fraprie, F. R. *See* Richards, T. W., and Fraprie, F. R.
Frost, E. B., Report of Progress to Rumford Committee, 521.

Gelasimus pugilator, 415.
Geometry on Ruled Quartic Surfaces, 17.
Glasgow, University of, Ninth Jubilee Celebration, 538, 542.
Glyphosperma Palmeri, 492.
Gray Herbarium of Harvard University, Contributions from, 453, 489.
Groups, Continuity of, 83.

Hale, G. E., Report of Progress to Rumford Committee, 522.
Hall, E. H., On the Thermal and Electrical Conductivity of Soft Iron, 119–141; Report of Progress to Rumford Committee, 523; An Exposition of the Theory of Electrons, the Electrical Fragments of Atoms, 542.
Hardystonite, 111.
Harvard Mineralogical Museum, Contributions from, 111.
Heat Capacity, Nomenclature of, 325.
Heterotoma Goldmanii, 504.
stenodonta, 504.
Hudson, E. J. *See* Mabery, C. F., and Hudson, E. J.
Hydrocarbons in Petroleum, 283.
Infinitesimal Transformations, 83.
International Atomic Weights, 169.
Ipomoea caudata, 498.
Iron, Conductivity of, 119.
Isopod Crustaceans, Tracks of, 67.

Jackson, C. L., and Behr, G. E., Symmetrical Triiodbenzol, 331–338.
Jackson, C. L., and Calhane, D. F., The Dinitro Compounds of Paradibrombenzol, 533.
Jackson, C. L., and Cohoe, W. P., Certain Derivatives of Metadibromdinitrobenzol, 73–82.
Jackson, C. L., and Earle, R. B., On the Action of Sodic Sulphite on Tribromdinitrobenzol, and Tribromtrinitrobenzol, 229–238.
Jackson, C. L., and Koch, W., On Certain Derivatives of Orthobenzoquinone, 195–228.
Jackson, R. T., Resorption as a Factor in Growth, 541.
Japanese Petroleum, 295.

Koch, W. *See* Jackson, C. L., and Koch, W.

Laboulbeniaceae, 395.
Laws, F. A., An Apparatus for recording Alternating Current Waves, 319–324; Report of Progress to Rumford Committee, 523.
Lewis, G. N., A New conception of Thermal Pressure, and a Theory of Solutions, 143–168; The Law of Physico-chemical Change, 542.
Librarian, Report of, 528.
Limulus polyphemus, 64; Trails of, 61.
Lobelia grauna, var. conferta, 503.
Nelsonii, 503.
regalis, 503.
Lowell, A., Bequest of, 534, 536.
Lyman, T., False Spectra from the Rowland Concave Grating, 239–252.

Mabery, C. F., Investigations on the Composition of Petroleum, 253–304.
Mabery, C. F., and Hudson, E. J., On the Composition of California Petroleum, 255–283.

Mabery, C. F., and Sieplein, O. J., On the Chlorine Derivatives of the Hydrocarbons in California Petroleum, 283–295.
Mabery, C. F., and Takano, S., On the Composition of Japanese Petroleum, 295–304.
Magnesic Oxalate, 375.
Manganous Sulphate, 507.
Marbles, Thermal Diffusivities of, 11.
Mayer, 328.
McCaffrey, C. F. *See* Richards, T. W., McCaffrey, C. F., and Bisbee, H.
Melampodium, Synopsis of, 455.
Melampodium Achillaeoides, 465.
Americanum, 459, 466.
angustifolium, 461.
appendiculatum, 457.
appendiculatum, var. leiocarpum, 457.
appendiculatum, var. sonorense, 457.
arenicola, 457.
arvense, 464.
australae, 465.
Baranguillae, 465.
Berterianum, 465.
bibracteatum, 465.
brachyglossum, 465.
camphoratum, 463.
cinereum, 458.
cinereum, var. argophyllum, 458.
cinereum, var. ramosissimum, 458.
copiosum, 465.
coronopifolium, 465.
cupulatum, 463.
diffusum, 460.
diffusum, var. lanceolatum, 460.
digynum, 465.
divaricatum, 465.
Dombeyanum, 466.
flaccidum, 464.
glabrum, 465.
gracile, 462.
heterophyllum, 460.
Hildalgoa, 466.
hirsutum, 466.
hispidum, 464.
humile, 466.
Kunthianum, 460.
lanceolatum, 466.
Melampodium leucanthum, 458.
Liebmannii, 466.
linearilobum, 459.
longicornu, 457.
longifolium, 465, 466.
longipes, 459.
longipilum, 458.
manillense, 466.
microcephalum, 462, 466.
mimulifolium, 462.
montanum, 463.
oblongifolium, 462.
ovatifolium, 466.
paludicola, 456, 466.
paludosum, 463.
panamense, 466.
paniculatum, 462, 466.
perfoliatum, 465.
Pringlei, 461.
pumilum, 466.
ramosissimum, 466.
rhomboideum, 466.
Rosei, 461.
Rosei, var. subintegrum, 462.
ruderale, 466.
sericeum, 459, 466.
sericeum, var. brevipes, 466.
sericeum, var. exappendiculatum, 459.
sericeum, var. longipes, 466.
sinuatum, 461.
suffruticosum, 456.
tenellum, 463.
ternatum, 466.
Melczer, G. *See* Wolff, J. E.
Merostomatous Trails, 61.
Merostomichnites beccheri, 67.
narragansettensis, 70.
Metadibromdinitrobenzol, 73.
Meteorological Observations, 305.
Mimosa acanthocarpa, var. desmanthocarpa, 472.
eurycarpoides, 472.
ionema, 473.
Watsoni, 473.
Montanoa arborescens, 487.
Monarda Pringlei, 501.

Nichols, E. L., Report of Progress to Rumford Committee, 523.
Nocca, Synopsis of, 467.
Nocca angustifolia, 470.
biflora, 468.
decipiens, 470.
glandulosa, 470.

Nocca helianthifolia, 468.
helianthifolia, var. levior, 468.
helianthifolia, var. suaveolens, 468.
heteropappus, 470.
Liebmannii, 470.
Moçinniana, 469.
mollis, 471.
Palmeri, 471.
Pringlei, 469.
rigida, 469.
tomentosa, 470.
Nomenclature of Heat Capacity, 325.
Nominating Committee, 535.

Officers elected, 530, 538; List of, 576.
Orthobenzoquinone, 195.

Packard, A. S., A New Fossil Crab from the Miocene Greensand Bed of Gay Head, 1–9; On Supposed Merostomatous and Other Paleozoic Arthropod Trails, 61–71.
Parathesis chiapensis, 497.
Pectis Lessingii, 506.
Peirce, B. O., Report of Progress to Rumford Committee, 525.
Peirce B. O., and Wilson, R. W., On the Thermal Diffusivities of Different Kinds of Marble, 11–16.
Pernettya ovata, 496.
Petroleum, 253.
Physalis puberula, 502.
Physical Laboratory of the Massachusetts Institute of Technology, Contributions from, 319.
Pickering, E. C., Report of Progress to Rumford Committee, 524.
Piqueria pyramidalis, 475.
Plateanus glabrata, 493.

Quartic Surfaces, 17.

Records of Meetings, 517.
Reissner's Fibre, 443.
Rhizomyces gibbosus, 409.
Rhodes, J. F., Sherman's March to the Sea, 536.
Richards, T. W., International Atomic Weights, 169–176; Suggestion concerning the Nomenclature of Heat Capacity, 325–329; Report of Progress to Rumford Committee 526; A Table of Atomic Weights, 545–546.
Richards, T. W., and Archibald, E. H., A Study of Growing Crystals by Instantaneous Microphotography, 339–353.
Richards, T. W., and Fraprie, F. R., The Solubility of Manganous Sulphate, 507–514.
Richards, T. W., McCaffrey, C. F., and Bisbee, H., The Occlusion of Magnesic Oxalate by Calcic Oxalate, and the Solubility of Calcic Oxalate, 375–393.
Robinson, B. L., Synopsis of the genus Melampodium, 455–466; Synopis of the genus Nocca, 467–471; New Species and newly noted Synonymy among the Spermatophytes of Mexico and Central America, 471–488; Recent Advances in the General Classification of the Flowering Plants, 541.
Ross, D. W., Design as a Science, 355–374.
Rowland Concave Grating, 239.
Ruellia cupheoides, 502.
Rumford Committee, Report of, 519; Reports of Progress to, 521.
Rumford Fund, Papers published by Aid of, 11, 119, 239, 339.
Rumford Premium, 595; Award of, 520, 529.
Russelia Deamii, 474.
trachypleura, 474.

Sabine, W. C., Report of Progress to Rumford Committee, 526; The Influence of Architecture on Melody and the Development of the Musical Scale, 537.
Salvia ageratifolia, 499.
albicans, 501.
Dugesii, 500.
igualensis, 500.
leucantha, for. iobaphes, 501.
setulosa, 499.
Sessei, 501.
tiliaefolia, var. rhyacophila, 499.

Sargent, P. E., The Development and Function of Reissner's Fibre, and its Cellular Connections, 443–452.
Schefferite, 111.
Sieplein, O. J. *See* Mabery, C. F., and Sieplein, O. J.
Slocum, S. E., On the Continuity of Groups generated by Infinitesimal Transformations, 83–109.
Sodic Sulphite, 229.
Solanum rostratum, var. subintegrum, 502.
Solar Eclipse of May 28, 1900, 305.
Solidago Pringlei, 505.
Solubility of Calcic Oxalate, 375; of Manganous Sulphate, 507.
Solutions, Theory of, 143.
Spectra, False, from the Rowland Concave Grating, 239.
Spelerpes bilineatus, 177.
Spermatophytes from Mexico and Central America, 471, 489.
Statutes and Standing Votes, 585.
Stigmatomyces constrictus, 401.
Diopsis, 399.
dubius, 402.
gracilis, 403.
humilis, 401.
Hydrelliae, 404.
Limnophorae, 400.
Limosinae, 406.
Papuanus, 407.
proboscideus, 403.
purpureus, 404.
rugosus, 398.
Scaptomyzae, 400.
spiralis, 405.
Symmetrical Triiodbenzol, 331.

Takano, S. *See* Mabery, C. F., and Takano, S.
Thaxter, R., Preliminary Diagnoses of New Species of Laboulbeniaceae, 395–414.
Thermal Conductivity of Iron, 119.
Thermal Diffusivities of Marbles, 11.
Thermal Pressure, 143.
Trails, Arthropod, 61.
Transformations, Infinitesimal, 83.
Treasurer, Report of, 517.
Tribromdinitrobenzol, 229.
Tribromtrinitrobenzol, 229.
Triiodbenzol, 331.
Trowbridge, J. Results obtained with a Storage Battery of Twenty Thousand Cells, 532.

Valeriana retrorsa, 502.
Variation in Fiddler Crab, 415.

Warren (C. M.) Committee, Report of, 527.
Warren (C. M.) Fund, Aid from, 253.
Wendell, B., Literary History of America, 535.
Williams, F. B., Geometry on Ruled Quartic Surfaces, 17–60.
Willson, R. W. *See* Peirce, B. O., and Willson, R. W.
Wolff, J. E., On Hardystonite and a Zinc Schefferite from Franklin Furnace, N. J.; with a note on the Optical Constants of the Schefferite by Dr. G. Melczer, 111–118.
Wright, J. H., Recent Excavations in Crete, 535.

Xanthocephalum megalocephalum, 505.

Yerkes, R. M., A Study of Variation in the Fiddler Crab, Gelasimus pugilator Latr., 415–442.

Zarabellia, 460.
Zoölogical Laboratory of the Museum of Comparative Zoölogy at Harvard College, Contributions from, 177, 415, 443.

Proceedings of the American Academy of Arts and Sciences.

Vol. XXXVI. No. 29.—June, 1901.

---

RECORDS OF MEETINGS, 1900–1901.

A TABLE OF ATOMIC WEIGHTS. By Theodore William Richards.

REPORT OF THE COUNCIL: BIOGRAPHICAL NOTICES.

Charles Carroll Everett. By Ephraim Emerton.

Nathaniel Horsford. By Jeremiah Smith.

Silas Whitcomb Holman. By Charles R. Cross.

Sylvester R. Koehler. By Charles G. Loring.

John Elbridge Hudson. By James B. Thayer.

John Harrison Blake. By Clarence John Blake.

Charles Edwards Dunbar. By Frank William Taussig.

OFFICERS AND COMMITTEES FOR 1900–1901.

LIST OF THE FELLOWS AND FOREIGN HONORARY MEMBERS.

STATUTES AND STANDING VOTES.

RUMFORD PREMIUM.

INDEX.

(Title-Page and Table of Contents.)

# PUBLICATIONS

OF THE

# AMERICAN ACADEMY OF ARTS AND SCIENCES.

---

MEMOIRS. Old Series, Vols. I.–IV.; New Series, Vols. I.–XII. 15 volumes, $10 each. Half volumes, $5 each. 25% discount to booksellers; 50% to members.

| | | | |
|---|---|---|---|
| Vol. I. | Part II. | 8vo | |
| " XI. | " I. | " | $3.00 |
| " XI. | " II. | No. I. | |
| " XI. | " III. | " II.–III. | |
| " XI. | " IV. | " IV. | |
| " XI. | " IV. | " V. | |
| " XI. | " V. | " VI. | |
| " XI. | " VI. | " VII. | |
| " XII. | No. I. | | |
| " XII. | " II. | | |
| " XII. | " III. | | $3.00 |
| " XII. | " IV. | | |

PROCEEDINGS. Vols. I.–XXXV., $5 each. 25% discount to booksellers; 50% discount to members.

---

A complete set of the MEMOIRS, 15 vols., for $112.50 to members, $60; of the PROCEEDINGS, 35 vols. for $131.25 to members, $70.